VOL. 25, No. 4 APRIL, 1948

# AMERICAN JOURNAL OF OPTOMETRY *and* ARCHIVES *of* AMERICAN ACADEMY OF OPTOMETRY

THE LIBRARY OF CONGRESS SERIAL RECORD
APR 26 1948
Copy

EDITORIAL COUNCIL

J. FRED ANDREAE, *Baltimore, Md.*
I. M. BORISH, *Kokomo, Ind.*
M. N. CHODROFF, *Brooklyn, N. Y.*
H. M. FISHER, *Mt. Kisco, N. Y.*
GLENN A. FRY, *Columbus, Ohio*
H. W. HOFSTETTER, *Columbus, Ohio*
D. G. HUMMEL, *Cleveland, Ohio*
E. A. HUTCHINSON, *Los Angeles, Calif.*
E. J. MARGARETTEN, *New York, N. Y.*
M. W. MORGAN, JR., *Berkeley, Calif.*
J. NEUMUELLER, *Haddonfield, N. J.*
C. A. RADDE, *Cleveland, Ohio*
H. SIMMERMAN, *Woodbury, N. J.*
C. L. TRELEAVEN, *New York, N. Y.*
A. P. WHEELOCK, *Des Moines, Iowa*

STAFF

CAREL C. KOCH, *Editor*, *Minneapolis, Minnesota*
ROBERT E. BANNON, *Research Editor*, *Hanover, New Hampshire*

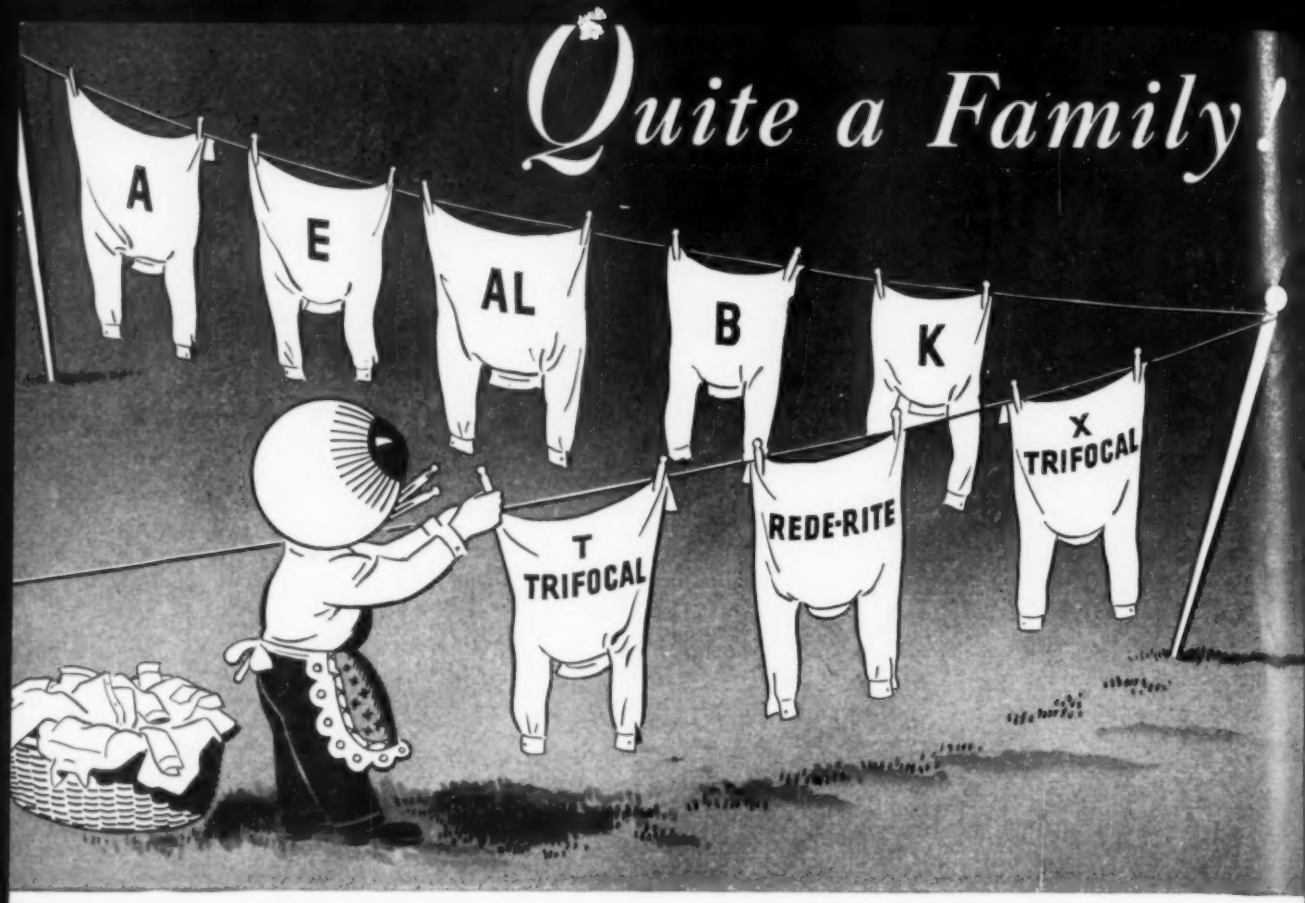
COLLABORATORS

A. N. ABBOTT, *Shawano, Wis.*
E. ALLGAIER, *Washington, D. C.*
M. ALPERN, *Cleveland, Ohio*
J. O. BAXTER, JR., *Beaufort, N. C.*
R. C. BAXTER, *Warren Ohio*
T. R. BELL, *Alpena, Mich.*
H. A. BEMIS, *Athol, Mass.*
E. A. BETTS, *Philadelphia, Pa.*
A. G. BILLMEIER, *Denton, Md.*
S. M. BRAFF, *Los Angeles, Calif.*
E. E. BRANN, *Independence, Kan.*
H. F. BRANT, *Des Moines, Iowa*
C. S. BRIDGMAN, *Columbus, Ohio*
G. L. BROWN, *Paulsboro, N. J.*
P. L. CONNOLLY, *Detroit, Mich.*
J. B. CONLOGUE, *Peoria, Ill.*
R. F. COOPS, *Los Angeles, Calif.*
J. C. COPELAND, *Chicago, Ill.*
J. R. DEAN, *Los Angeles, Calif.*
W. E. DEWEY, *Battle Creek, Mich.*
I. DVORINE, *Baltimore, Md.*
M. T. EBERL, *Milwaukee, Wis.*
V. J. ELLERBROCK, *Hanover, N. H.*
T. A. W. ELMGREN, *Columbia, S. C.*
A. B. EMMES, *Richmond, Calif.*
H. W. EWALT, JR., *Pittsburgh, Pa.*
W. S. FARMER, *Oklahoma City, Okla.*
R. FEINBERG, *Lafayette, Ind.*
W. FEINBLOOM, *New York, N. Y.*
L. P. FOLSOM, *South Royalton, Vt.*
H. L. FUOG, *Los Angeles, Calif.*
E. FREEMAN, *Chicago, Ill.*
W. H. GLAZER, *Philadelphia, Pa.*
E. I. GOODLAW, *Los Angeles, Calif.*
R. C. GRAHAM, *Pasadena, Calif.*
W. GREENSPON, *Bluefield, W. Va.*
D. E. GRIM, *Cedar Rapids, Iowa*
H. F. HAINES, *Columbus, Ohio*
R. M. HALL, *Cleveland, Ohio*
W. J. HEATHER, *Southbridge, Mass.*
A. E. HOARE, *Los Angeles, Calif.*
E. E. HOTALING, *New York, N. Y.*
O. H. JOHNSON, *Jonesboro, Ark.*
R. S. JORDAN, *Cleveland, Ohio*
J. C. KEHOE, *Flint, Mich.*
W. M. KETCHUM, *Los Angeles, Calif.*
G. F. KINTNER, *Wabash, Ind.*
L. H. KRASKIN, *Washington, D. C.*
A. R. LAUER, *Ames, Iowa*
M. LUCKIESH, *Cleveland, Ohio*
G. A. MACELREE, *Philadelphia, Pa.*
O. L. MCCULLOCH, *Holyoke, Mass.*
H. B. MARTON, *Manchester, Eng.*
J. W. MOGEY, *Flushing, N. Y.*
C. W. MORRIS, *Fort Wayne, Ind.*
J. C. NEILL, *Philadelphia, Pa.*
J. S. NUPUF, *Canton, Ohio*
D. R. PAINE, *Topeka, Kan.*
G. A. PARKINS, *Ord, Nebr.*
E. PETRY, *Rochester, N. Y.*
H. E. PINE, *Chicago, Ill.*
E. E. REESE, *Westerville, Ohio*
R. J. ROTH, *Southbridge, Mass.*
E. LEROY RYER, *New York, N. Y.*
C. I. SAKS, *Syracuse, N. Y.*
A. A. SCHMIDT, *Cleveland, Ohio*
C. SHEARD, *Rochester, Minn.*
J. ROBERT SHREVE, *Indianapolis, Ind.*
S. H. SHURIN, *Kansas City, Mo.*
R. E. SIMPSON, *Pasadena, Calif.*
W. SMITH, *Boston, Mass.*
E. J. SOLAND, *Indianapolis, Ind.*
P. L. SPENCER, *Claremont, Calif.*
K. B. STODDARD, *Berkeley, Calif.*
M. A. TINKER, *Minneapolis, Minn.*
A. H. TWEEDLE, *Kenora, Ont.*
R. N. WALKER, *Winston-Salem, N. C.*
W. G. WALTON, JR., *Merion, Pa.*
RITA WALSH, *Chicago, Ill.*
G. H. WARKENTINE, *Cedar Rapids, Iowa*
E. G. WISEMAN, *Buffalo, N. Y.*
A. T. WRAY, *Los Angeles, Calif.*

Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION,
1502 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

ANNUAL SUBSCRIPTION $5.00 CANADA $5.50, FOREIGN $6.00
Single copies, 50c

Entered as second-class matter, February 20, 1924, at the post office at Minneapolis 2, Minnesota, under the Act of March 3, 1879.
Established 1924




# Quite a Family!

When you have a case calling for bifocals or trifocals, prescribe Continental Ultex. No need to rack your brain, worry yourself or waste valuable time wondering where to get the lens best suited.

What a selection you have with Continental Ultex—a choice of styles, a choice of base curves, a choice of clear and tints.

It's quite a family, the Continental Ultex line. Each member has its individual characteristics, but there's a strong onepiece resemblance and the same ophthalmic quality.

## STYLES · BASES · TINTS

*of Continental Ultex*

| Style | Base | Clear | Pink | | Green | | |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | A | B | C |
| A | Plano | X | | | | | |
| | 4.00 | X | X | X | | X | |
| | 6.00 | X | X | X | | X | X |
| | 8.00 | X | X | X | | | |
| E | 4.00 | X | X | X | | | |
| | 6.00 | X | X | X | | | |
| | 8.00 | X | X | X | | | |
| K | 4.50 | X | X | X | X | X | |
| | 6.50 | X | X | X | | X | X |
| | 7.50 | X | X | | | | |
| | 8.50 | X | X | X | | | X |
| | 9.50 | X | X | | | | |
| B | Plano | X | | | | | |
| | 4.50 | X | X | X | | X | |
| | 6.50 | X | X | X | | X | X |
| | 8.50 | X | X | X | | | |
| AL | 6.00 | X | X | | | | |
| X | 4.00 | X | | | | | |
| | 6.00 | X | X | X | | | |
| T | 6.50 | X | X | | | | |
| New Rede-Rite | 4.50 | X | X | | | | |
| | 6.50 | X | X | X | | | |
| Cataract | −6.00 to +6.00 | X | | | | | |
| See-Step | 6.00 | X | | | | | |

Continental · INDIANAPOLIS

## AMERICAN ACADEMY OF OPTOMETRY

Dr. Harold M. Fisher, *President*
Mt. Kisco, New York

Dr. D. G. Hummel, *Vice-President*
Cleveland, Ohio

Dr. Carel C. Koch, *Secretary*
Minneapolis, Minn.

## EXECUTIVE COUNCIL

Dr. Harold M. Fisher, *Chairman*
Mt. Kisco, N. Y.

Dr. D. G. Hummel, *Vice-Chairman*
Cleveland, Ohio

Dr. Carel C. Koch, *Secretary*
Minneapolis, Minn.

Dr. J. Fred Andreae, *Past President*
Baltimore, Md.

Dr. Robert E. Bannon
Hanover, N. H.

Dr. John R. Dean
Los Angeles, Calif.

Dr. W. Edward Dewey
Battle Creek, Mich.

Dr. Laurence P.Folsom
South Royalton, Vt.



Office: American Academy of Optometry: 1502 Foshay Tower, Minneapolis 2, Minn.

The AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY serves as the official publication of the American Academy of Optometry. It is published monthly by the American Journal of Optometry Publishing Association under the editorial supervision of the American Academy of Optometry.

Publication Office: 1502 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.


# AMERICAN JOURNAL OF OPTOMETRY *and* ARCHIVES *of* AMERICAN ACADEMY OF OPTOMETRY


Vol. 25 — No. 4


## CONTENTS


ORIGINAL PAPERS

The Method of Science. Eugene Freeman . . . . . 153

Mechanisms Subserving Simultaneous Brightness Contrast. Glenn A. Fry . . . 162

Report on a Family With Sub-Luxated Lenses. Simon Sculler . . . . . 179

EDITORIALS

An Example of the Method of Science. Eugene Freeman . . . . . 184

SPECIAL REPORT

Criticism of Certain Dispensing Practices and Its Effect Upon Optometry. Joseph G. Majersky and Carel C. Koch . . . . . 188

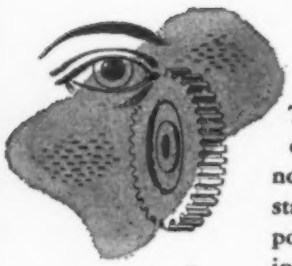
TRANSACTIONS OF THE ACADEMY . . . . . 192

CURRENT COMMENTS . . . . . 194

CORRESPONDENCE . . . . . 198

# BAUSCH & LOMB INDUSTR

# What it



The Bausch & Lomb Industrial Vision Service is now in the beginning stages of becoming an important production factor in the industry of America. It opens up what is likely to prove the greatest opportunity for professional services in the history of the science of eye care. It carries with it, too, equal responsibility. On the ability of optometrists, ophthalmologists and opticians to render needed professional services depends the value of the B&L Industrial Vision Service to industry.

## 8 YEARS TO PROVE ITS SOUNDNESS

The development of the Bausch & Lomb Industrial Vision Service has been deliberate and thorough. Its importance in industry and in the ophthalmic professions was early recognized and each step has been subject to most searching proof. For more than eight years the Bausch & Lomb-sponsored research at Purdue University has been building a record of positive accomplishment. To date, statistically-determined visual standards have been set for more than a thousand different jobs.

## PRODUCT OF RESEARCH AND COLLABORATION

Authoritative practitioners and committees in the ophthalmic professions have collaborated in the research and policy-formation of the Industrial Vision Service. The assistance of these groups assures that the program is professionally feasible as well as scientifically valid.

## SCIENTIFIC FACT-FINDING

The heart of the Industrial Vision Service is its actuarial *fact-finding* method. No preconceived notion or individual opinion of "adequate vision" is used as a standard of visual performance. Individually-measured visual skills are correlated with actual job performance for the determination of standards by which are identified those in need of professional service. This is the new approach of the B&L Industrial Vision Service. It is in addition to conventionally-determined standards from a health point of view.

## PROOF OF THE VALUE OF PROFESSIONAL SERVICE

Industrial management is able to recognize—in terms of increased production, improved quality, reduced accident rates, lowered training costs, improved worker earnings—the effectiveness of skilled professional eye care. Thus, the result of the Industrial Vision Service installed in your community is for the first time to put a measurable dollars-and-cents value on professional service.

## VAST FIELD FOR PROFESSIONAL SERVICE

It is now evident that there is no type of industry or business which does not stand to benefit from installation of the Bausch & Lomb Industrial Vision Service. As the impact of its advantages is felt, more and more of the wage earners in your community will be handed the referral slips that make them immediate candidates for the benefit of your professional services.

# RAL VISION SERVICE

# *means to You*

## PUBLIC IS VISION CONSCIOUS

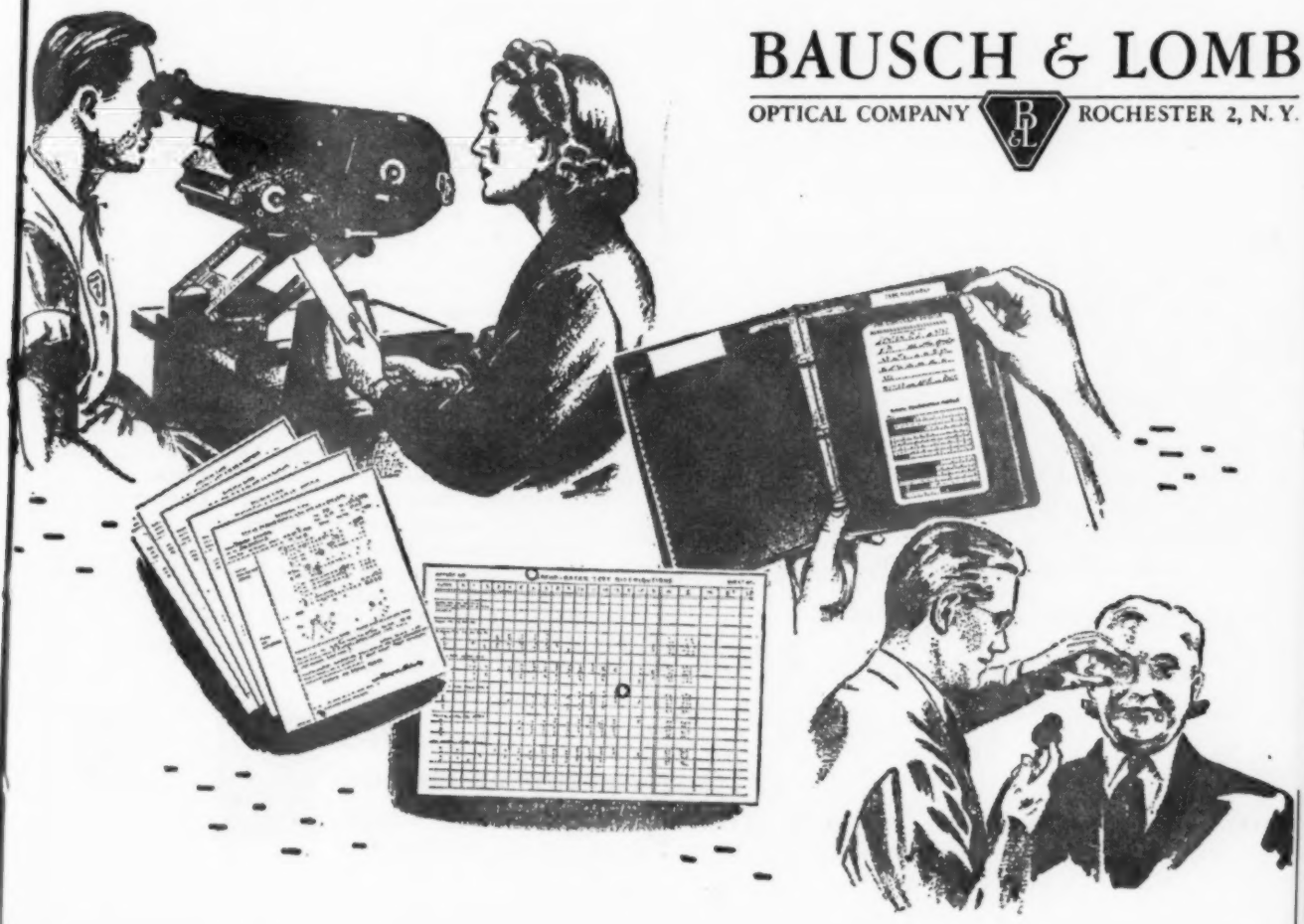
Already, the concept of *vision for the job* has become the subject of wide publicity. Industrial and business management and workers alike are being made aware of the dependence of production efficiency on visual ability. A corollary effect is possibly even more important to the ophthalmic professions—members of families and friends, who, learning of the benefits of professional eyesight service, want the advantages for themselves.

## SURE, SOLID, PROFESSIONAL GROWTH

The administration of the Bausch & Lomb Industrial Vision Service in industry is a systematized, routine procedure. The advantages to industry accrue as the effects of professional service on referred workers are felt. In any community, responsibility for needed professional services is shared by all who are able to render such services. The result is steady and solid growth in professional accomplishment, professional recognition, professional prestige.

BAUSCH & LOMB

OPTICAL COMPANY B&L ROCHESTER 2, N. Y.



# HIGHEST HONOR
## awarded to
## Better Vision Institute
## ADVERTISING

THE DISTINGUISHED JURY
OF THE
ANNUAL ADVERTISING AWARDS
HAS SELECTED
BETTER VISION INSTITUTE, INC.
TO RECEIVE THE

## MEDAL AWARD

(HIGHEST AWARD)
FOR EXCELLENCE IN
ASSOCIATION ADVERTISING
FOR THE YEAR 1947

BETTER VISION INSTITUTE, INC., NEW YORK CITY

**HIGHEST HONORS to all who generously support the work of the Better Vision Institute.**

### MANUFACTURERS

American Optical Company • Bausch & Lomb Optical Co. • Bay State Optical Co. • The Kono Mfg. Co. • Frank Krementz Co. • Marine Optical Manufacturing Co. • Shuron Optical Co., Inc. Soft-Lite Lens Co., Inc. • Titmus Optical Co., Inc. • The Univis Lens Co. Victory Optical Mfg. Co. • Virginia Lens Company, Inc. • Zylite Products Co.

### SUPPLY HOUSES

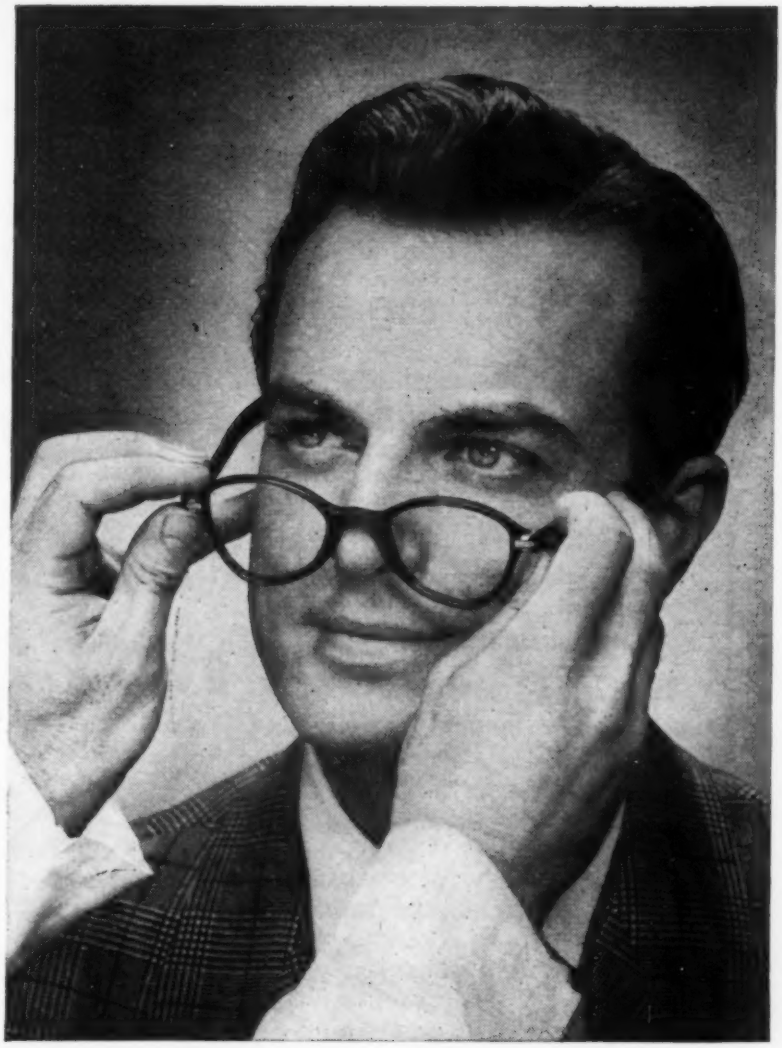
American Optical Company (All Branches) A. F. Appleby Optical Co. • Fred J. Balester and Sons • Bausch & Lomb Optical Co. (All Affiliates) • N. P. Benson Optical Co., Inc. Big Spring Optical Co. • Binghamton Optical Co. • Broome Optical Company • Burleigh Optical Co. • Capitol Optical Company Central States Optical Co., Inc. • Chaffin Optical Co. • Clinton Optical Co., Inc. • Colonial Optical Co., Inc. (All Branches) • The Dempsey Optical Co. • Dietz Optical Co. A. E. Doble • Dow Optical Co. • Fort Wayne Optical • Fox Optical Co. • Fry Optical Co. • Geneva Optical Co. • Gregory Optical Co. • Joseph Greiff, Inc. • Hedrick Optical Co. • Heilman Optical Co. • H. & M. Optical Co., Ltd. • A. E. Holden Optical Co. • Homer Optical Co. • Hooker Optical Co. • Hygrade Optical Co., Inc. • Kalamazoo Optical Co. • Kirstein Optical Co., Inc. McClenaghen Optical Co. • F. H. McGary Optical Co. • McIntire, Magee & Brown Co. (All Branches) • McLeod Optical Co., Inc. Maves Optical Co. • R. Mohr & Sons • S. R. Nay Company • Niagara Optical Co. Northwest Optical Laboratories • Old South Optical Co. • Optical Service of Florida Ostertag Optical Service • Philadelphia Optical Co. • Herman Pollack • Precision Optical Co. • Ray Optical Co. • Reese Optical Co., Inc. • Riggs Optical Co., Consol. (Chicago; All Branches) • Riggs Optical Co., Inc. (San Francisco; All Branches) • B. Robinson Optical Distributor • Schwartz Optical Co., Inc. • Southeastern Optical Co., Inc. (All Branches) • Victory Opticians • Wakefield Optical Company, Inc. • The Walman Optical Co. • Western Optical Co. • The White-Haines Optical Co. (All Branches) Wilson & Halford Optical Co. • Winchester Optical Co. • Youngstown Optical Co.

THE NEED
FOR EDUCATION
NEVER ENDS

BVI

# 60 SECONDS AND A SCREWDRIVER

Baylok's patented split-joint construction makes assembly of a shell frame as easy as metal. All you need are 60 seconds and a screwdriver. Simply remove screw, take off temple, push clevis forward; rim then comes apart at the joint for easy insertion of lens. No more heating of frames with chance of spoiling finish or unnecessary breakage. Temples and fronts join simply and easily in a perfect mitre fit. Baylok also offers other exclusive features such as a full fashioned front which provides strong reinforcement at the strategic points where strength is needed; new Orbiton shape, optically correct and cosmetically appealing; combination saddle and pad bridge for greater comfort. If you are not already using this remarkable new frame, start today and see for yourself these and the many other advantages exclusive to Baylok.



## *Baylok* BY BAY STATE

BAY STATE OPTICAL COMPANY. ATTLEBORO, MASS.

CHICAGO: 29 EAST MADISON STREET

*Traditional Craftsmanship Since 1862*

# A TELEBINOCULAR and a TEL-EYE-TRAINER

**The New Keystone Telebinocular with the Ortho-Trainer and the Rotor Control**

## A Sturdy Telebinocular and Regular Slide Holder with—

1. Lenses corrected for color and spherical aberration.
2. Removable lens wells adapted to wide and narrow P.D.'s.
3. Special illuminant under the lens wells so that the technician can look into the patient's eyes.
4. Substantial base and well-balanced supporting arm.

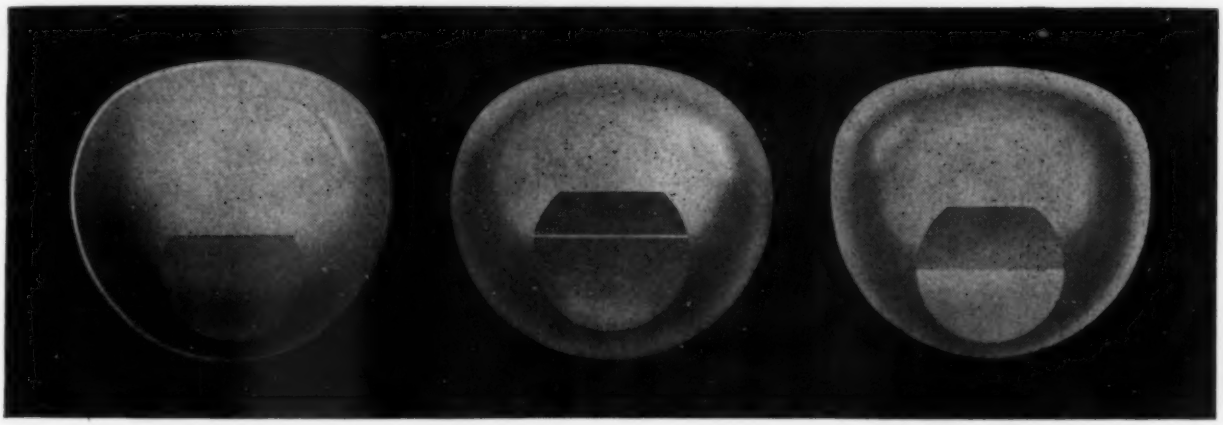
## The Ortho-Trainer is a SPECIAL slide carrier with the following features:

1. The holders accommodate TRANSPARENT split slides as well as OPAQUE split cards.
2. As the Ortho-Trainer is moved back and forth, toward and away from the patient, the MECHANISM may be set so that constant ORTHOPHORIC separation is maintained.
3. Similarly the mechanism may be set so that CONSTANT SEPARATION may be maintained as the Ortho-Trainer is moved back and forth.
4. Or the mechanism may be set at any prism separation, so that, AT ANY position the split slides may be moved in and out for duction or accommodative training.
5. Electric connections are furnished for connecting the lamps to an ordinary outlet for CONSTANT illumination, or for connecting it to the Rotor Control for the SPECIAL Tel-Eye-Trainer flash-training procedures.
6. Several NEW SERIES of training split slides are available with special emphasis on near-point problems, and accommodative and duction training for ALL types of CASES.

Further Information Will Be Furnished on Request.

**KEYSTONE VIEW CO. Meadville, Pa.**

PIONEERS IN VISION-TRAINING EQUIPMENT



The Univis D | The Univis General Purpose Trifocal | The Univis Vocational Trifocal

# *Getting the Most Out of the Univis*

# COMPLETE MULTIFOCAL SERVICE

**New lenses?** Certainly not. But there is definitely something new *about* them.

It's GG-7, the revolutionary new Univis segment glass. With segments in GG-7, the following may be said of these Univis lenses:

**1.** *They are manufactured up to the maximum benefit of their finer design.*

**2.** *They are no longer restricted by raw materials which had fallen far behind.*

**3.** *They permit prescriptions to be filled with far greater intricacy of detail than ever.*

**4.** *They are endowed with every single attribute of lenses with segment glass that leaves nothing to be desired.*

Soon other members of the Univis Complete Multifocal Service will be available with segments in GG-7. Watch for announcement.

**THE UNIVIS LENS CO. • Dayton 1, Ohio**

# Univis

**BIFOCALS AND TRIFOCALS**

# Forty Years of Manufacturing "Lenses Worthy of Their Name"

THIS year is TITMUS' 40th Anniversary. Ever since 1908, when our Founder and President, Edward H. Titmus, started making ophthalmic lenses in his little Sycamore Street store, the TITMUS guiding principle has been and always will be, "FIRST QUALITY"—"Perfex," "Bonvue,"—"Velvet-lite"—"Contra-Glare"!

**TOP:** First TITMUS lenses were made in small shop in rear of this retail store at 22 Sycamore Street. **RIGHT:** In 1920, 400 men and women were employed in this TITMUS plant. **ABOVE:** Recent aerial photo partially shows the several TITMUS plants in Petersburg today.

Titmus

BVI

TITMUS OPTICAL CO. PERFEX PETERSBURG, VA. U.S.A.

## OPTICAL COMPANY, INC.

*"World's Largest Independent Manufacturers of First-Quality Ophthalmic Lenses"*

**PETERSBURG, VIRGINIA, U. S. A.**

THE ART OF DESIGNING . . . THE CRAFT OF FASHIONING
IN METAL IN ZYL

No. 5275 1/10 12K Gold-Filled
with 10K Gold Bridge

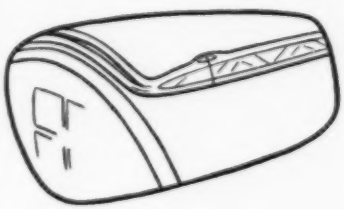
Artcraft's

*Delmar* STYLEFLO ARCWAY FUL-VUE

Fashion-wise women like the Delmar's pierced-bridge styling, the hinge-concealing beauty of its Styleflo No-Korod temples.

Practitioners like the Delmar because it's so easy to fit . . . because the lenses stay correctly aligned even under hard wear . . . because it's so comfortable patients forget they're wearing glasses.

You, too, will find Art-Craft's Delmar a dependable patient-pleaser and a potent practice-builder.

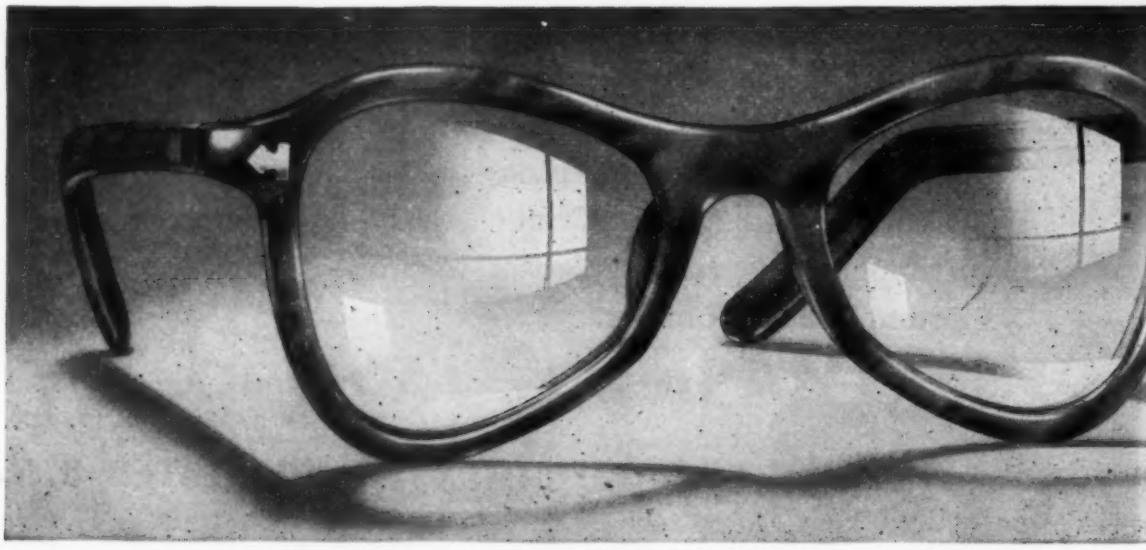


Artcraft OPTICAL COMPANY • ROCHESTER 6, N. Y.

# New Intermediat

# AO WEYMOUTH FUL-VUE

By skillfully increasing the zylonite dimensions of the AO Weymouth Ful-Vue, AO Designers have created a sensationally different Weymouth—new in cosmetic appeal, yet old in ophthalmic advantages. In addition to the increased zyl stock, spatula temples and four fancy arrowhead rivets complete the modern styling of the new Weymouth. The increased dimensions of the eyewire serve to magnify all color values, giving a new, over-all color appearance in pink crystal, demi-blonde, demi-amber or Glograin. The new weight provides extra rigidity and durability. It is heavy enough to meet the style demands of both men and women, light enough for comfortable wear.



*The new Weymouth combines ophthalmic precision and modern styling.*

# Weight

The new Weymouth maintains its ophthalmic advantages. The three-position bridge has been retained. The frame is well balanced, fits and stays firmly on the patient, keeps lenses in accurate alignment. For modern style, plus long-established ophthalmic features, see the new AO intermediate weight Weymouth.

**ACTUAL SIZE**

*Shaded area of diagram shows increased stock in width of eyewire. Inset shows actual size difference.*

American Optical COMPANY

# *Two new members of a . . .*

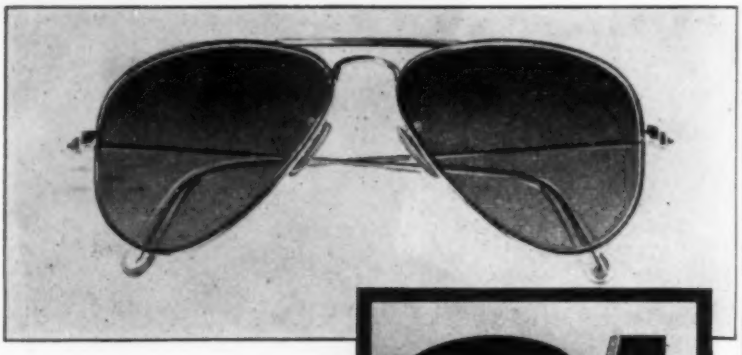
# FAMOUS FAMILY

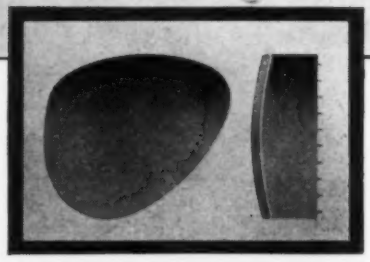
Ray-Ban

## GRADIENT DENSITY SUN GLASS

The new Ray-Ban Gradient Density Sun Glass is designed to solve the problem of unequal glare intensities by adding extra glare protection in the upper Ray-Ban lens areas. This is achieved by applying to the Ray-Ban lenses a durable film of stainless steel, starting with a zero thickness at the center and gradually increasing toward the top, so that light transmission at this point is very low—about 1/10 of one percent.

Thus the center of the Ray-Ban lens provides normal glare protection while the gradual darkening above completely eliminates unwanted abnormal glare.





Gradient Density Metallic Coating at Top

***Large Ray-Ban Density Metal Sun Glass, 1/10 12K Gold Filled, 58 x 50.5mm 6.00 D curve lenses.***

Ray-Ban

## JUNIOR SUN GLASS

This brand new Ray-Ban Sun Glass is designed for children below the 'teen age. It is a miniature Skeet glass, with plastic-covered brow bar to prevent lens fogging, flexible cable temples and adjustable nose pads. The lens shape has been modified to better meet the glare-protective needs of juvenile wearers, and lenses are hardened to resist impact.

***Ray-Ban Junior Metal Sun Glass, 1/10 12K Gold Filled, 44 x 37mm 6.00 curve lenses.***

***Ask your Riggs Representative to show you the complete line of Ray-Ban Sun Glasses.***

## RIGGS OPTICAL COMPANY

***Distributors of Bausch & Lomb Ophthalmic Products***

**General Offices: Chicago, San Francisco**
**Branches in Principal Western & Mid-Western Cities**

AMERICAN JOURNAL OF OPTOMETRY
*and* ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Vol. 25 APRIL, 1948 No. 4

# THE METHOD OF SCIENCE*

Eugene Freeman†
Chicago, Illinois

## A. THE MEANING OF SCIENCE

The term science has two very closely related but widely different meanings which must be distinguished carefully if the word is to be properly understood. The difficulty arises from the fact that the two meanings of the word science are not mutually exclusive, but differ only in their degree of generality, the more general meaning including the restricted meaning as a special case. The word "man" illustrates in a simple fashion the same type of ambiguity—the word may mean either (1) a species of animal technically known as "homo sapiens," or (2) an individual adult male member of that species.

In its most general sense, the word science is approximately the equivalent of the Latin word *scientia* (meaning knowledge or learning) from which it was originally derived, and thus means any system of organized knowledge, such as, e.g., mathematics. In its restricted sense, science means *natural science*, which is distinguished from science in general in at least two respects: (1) its data are limited to facts, i.e., natural phenomena; and (2) it is characterized by a highly specialized method of procedure, the *experimental method*, which consists essentially of controlled factual observations systematized by inductive reasoning.

By widespread usage, the term science is understood to mean science in the restricted sense of natural science, unless the context makes such a restriction manifestly impossible. This is particularly true of derivatives such as scientist, scientific, etc., which are invariably derived from science in the sense of natural science. It would be simpler and more precise to have two separate words to designate the two meanings of the

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 15, 1947. For publication in the April, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Fellow, Americam Academy of Optometry. Assistant professor of philosophy, Illinois Institute of Technology. Executive Dean, Chicago College of Optometry.

word science, as is done, for example, in the German language, in which the word *Wissenschaft*, which is best translated by the English word "knowledge" or "scholarship," is used exclusively to designate what we mean by "science in the most general sense," and in which the word *Naturwissenschaft* is used as the exact equivalent of the English term science in the sense of natural science. A corresponding discrimination between the two senses of the word science will be made in this paper by the stipulation that the word science will be intended to mean natural science, unless a specific qualification is made to the contrary, as for example by the use of the term "formal science" to designate science in its most general sense.

Perhaps the best definition of the word science in the sense of formal science is found in Funk and Wagnall's Practical Standard Dictionary: "Science is knowledge related to law and embodied in system." The chief virtue of this definition is its insight into the crucial importance of law as part of the meaning of science in both senses of the word. The unabridged Century Dictionary, which is the final authority as far as dictionaries are concerned, has a lengthy statement on the meaning of science which will repay careful reading. It offers numerous definitions, e.g., "1. Knowledge; comprehension or understanding of facts or principles. 2. (a) Knowledge gained by systematic observation, experiment, and reasoning; (b) knowledge coordinated, arranged, and systematized; also (c) *the prosecution of truth as thus known . . .*"* Meanings (1) and (2) define formal science and natural science respectively, except for (2b) which obviously defines formal science and should have been listed under (1), a mistake which illustrates the difficulty of separating the two senses of the word. The item which is particularly significant however, is (2c), which defines science as the *prosecution* of truth, rather than as the body of truth or knowledge itself which is so gained.

The most successful definition of natural science is one which defines it as being a "prosecution" or a "method of prosecution" rather than as the body of knowledge which is its accomplished result. It has been said that "the history of science is strewn with the corpses of untrue theories and false facts;" and it is a truism today that the permanent structure of science is not its content, which is for the most part "dated" and rapidly outmoded, but its *method of inquiry*, the principles of which are relatively timeless and unchanging. From this point of view we may define natural science as an inductive experimental *method* of deriving and confirming hypotheses, theories, and laws descriptive of

*Italics and letters in parentheses mine.

natural phenomena and their changes, in order to understand nature, and to predict and control its changes. (The various technical terms introduced in this definition will be explained in the subsequent development of the paper.)

This view does not deny the inescapable truth that the method of science is primarily a means to an end, and that whatever *value* science may have is the value of its results at any given date, however tentative and dated these results may be. What is insisted upon here is that an understanding of the *meaning* of science consists essentially of an understanding of the *method* of science.

B. STEPS IN THE METHOD OF SCIENCE

1. *Observation:*

The first step in the method of science consists of the observation of facts or natural phenomena. A fact is something which is *really* true, as opposed to that which is a mere belief; a natural phenomenon is an entity or occurrence which is known to us through the senses. One of the basic presuppositions on which all science is founded is the postulate that natural phenomena are the most fundamental and unquestionable facts which can ever be known. (There are certain philosophical difficulties which this presupposition raises, but in the light of the enormous success of science these difficulties may be safely ignored.) The accumulation of facts by careful observations which are not controlled by a guiding hypothesis is called Baconion science, in honor of Francis Bacon.

2. *Classification:*

The first observations made by Baconion investigation are random, unsystematic, and unselected, but as observations accumulate they begin to suggest hypotheses concerning possible orderly connections between some of the facts observed. A tentative scheme of classification is then formulated, on the basis of which the available data may be hypothetically organized and new observations may be systematically made.

3. *Formulation of a problem:*

The entire work of science, from its most primitive beginnings to its most highly evolved forms, from its first step to its last, may be said to consist of the two-fold process of *describing* and *arranging* facts. As a result of the preliminary observations and hypothetical classifications with which science begins, further problems of description and arrangement arise. Description is an essentially factual process, and may be

carried out with the highest degree of certainty that science is capable of achieving. But even description, to be useful, must be guided to a certain extent by some speculations concerning the relevance of the facts selected by the observer to be described—just as a camera, which is capable of rendering a faithful picture of whatever it is pointed at, needs to be aimed by its user at something significant if the picture it takes is to be worth keeping. Thus the problem raised by description is the problem of relevant selection of the facts to be described, and this is a problem for which no immediate factual or observational solution is possible.

"Arrangement," unlike description, is an essentially nonfactual procedure, for its results can never be confirmed by direct observation, and thus can never be more than probable. The problem of arrangement is the problem of determining the nature of the logical or causal connections between facts; in other words, it is the problem of classifying facts, and determining their causes, and integrating what is known about facts into an intelligible and orderly system.

The third step in the method of science consists then in the formulation of a specific problem, of either description or arrangement of the facts at hand—typical problems being: (a) what features of phenomenon K should be selected for description, and how complete the description should be for an adequate understanding of the nature or causal relationships of the phenomenon to be gained; or (b) what is the cause of K; or (c) is there any causal connection between K and X, K and Y, etc.?

4. *Formulation of a hypothesis:*

While the first three steps enumerated above are logically separable, in practice they may be telescoped together; in which case the first step in science may be said to be the formulation of a problem concerning the description or arrangement of certain facts which have been observed. The next step consists in the formulation of a hypothesis by means of which the problem is tentatively solved. A hypothesis may be defined as the tentative conjectural solution of a problem concerning phenomena or their changes for which no immediate or direct factual solution is possible.

Hypotheses are universals in the philosophic sense; accordingly, they can never be fully tested or fully validated by experience. The method of empirical science is essentially a method for establishing, not the "truth" in any absolute sense, but the usefulness of hypotheses, that

is, their pragmatic truth. The term confirmation is used typically to designate the process of pragmatic verification of the hypothesis.

Any hypothesis can be confirmed only through sensory experience, and then only (a) indirectly, and (b) tentatively. The relevant sensory experience consists of *controlled* observation, as distinguished from random or accidental observation. The indirect character of the confirmation consists of (a) stating a *particular* logical consequence or direct implication of the hypothesis in the form of a *prediction* which can be tested by controlled observation; and then (b) making the observational test of the prediction.* The tentative character of the confirmation results from the fact that while an infinite number of empirical tests would be required to establish the *absolute* truth of the hypothesis, we know *a priori* that only a finite number of empirical tests can ever actually be made. Accordingly, no hypothesis involving "hard data" or brute facts can ever be more than probable or acceptable except on a tentative basis.

The primary requirement of a good scientific hypothesis is that it must be capable of independent observational verification. For example, a hypothesis might be formulated which would attempt to account for the hatching of an egg into a chick by postulating that there is present in the egg a conscious intention to become a chick. It would obviously be impossible to confirm this hypothesis by any observations independent of the observations which have suggested the problem, namely, that eggs do hatch into chicks.

A second characteristic of a scientific hypothesis is that it must have a sufficient degree of generality to be capable of explaining other sets of facts besides those which raise the problem. For example, Newton's hypothesis of universal gravitation not only accounts for the falling of objects to the earth, but for the movements of the planets as well. Thus the scientific hypothesis is *fruitful*, and helps us to discover new and independent facts. The chief difference between the scientific hypothesis and the unscientific hypothesis (sometimes spoken of as an *ad hoc* hypothesis) is that while either one may account for a given set of facts equally well, the *ad hoc* hypothesis is barren and incapable of being applied to any other facts, while the scientific hypothesis can be integrated into the body of science.

This suggests a third characteristic of scientific hypotheses, or rather a criterion by means of which they are evaluated. A hypothesis

*The testing of an implication of a scientific hypothesis by means of controlled observation constitutes an "experiment."

which is itself in agreement with the accepted results of the science with which it is contemporary is *prima facie* more acceptable than one which would be in direct conflict with established science. The former hypothesis can use as part of its own confirmation the observations and the theories on which the preceding accepted science has been built.

The new conflicting hypothesis must not only be capable of independent verification (as any hypothesis must be) but it must also involve as part of its own confirmation the disconfirmation by means of predictions and observational tests of any established theories with which it conflicts.

On rare occasions this has been done successfully, and it is one of the unique virtues of science that no matter how well established the older theories may be, if the new conflicting hypothesis can be demonstrated to be in better concordance with all of the facts than the old, then it is accepted and the old one is superseded. The most dramatic example in the history of science, of course, is the case of the superseding of Newton's hypothesis of universal gravitation and the entire structure of classical physics which rests upon it by Einstein's hypothesis of relativity.

It had previously been observed that the perihelion of Mars shifted 43 seconds of arc per century. This could not be explained in Newtonian terms, but was a direct implication of Einstein's. Two further sets of data were also found to be consistent with Einstein and in conflict with Newton, namely, (a) a shift in the lines of the star spectra toward the red end had been observed. There is no way of accounting for this shift in Newtonian terms, but it is easily accounted for in Einsteinian terms as an effect produced by the surface gravitation of the stars on the light emitted by the star; and (b) a similar closely related phenomenon, which has been termed "the Einstein effect," was *predicted* directly from Einstein's theory of gravitation—namely, that the rays of light coming from a distant star to the earth would be deflected by the gravitational effect of the sun if the rays were to pass close enough to the sun. Einstein calculated that for a ray passing directly alongside of the sun, the deflection would be equal to 1.7 seconds of arc although, of course, a total eclipse of the sun would be required for the observation of the phenomenon. This prediction was confirmed shortly before the first world war, and constituted the final crucial experimental evidence on the basis of which Newton's theory was considered superseded.

On the other hand, a hypothesis which conflicts with established

science is very properly given short shrift. Before it can even be given an audience, its framer must:

> (a) demonstrate that every prior theory with which it conflicts has predictable logical consequences which can be demonstrably disconfirmed by empirical observation;
>
> (b) that the new hypothesis will successfully account for every empirical fact by means of which the old theory is disconfirmed, and at the same time account equally well for every observation previously explained by the older theories.

We can understand, therefore, why the best scientific hypotheses are usually made by the men in a given field of science who (1) have made the most extensive observations of the phenomena investigated in that field; and/or (2) have gained an intimate understanding of the established results which have been achieved in that field; and/or (3) possess a certain measure of creative imagination or scientific genius which enables them to make inspired guesses.

It is in the degree of the possession of this third attribute of creative imagination that greatness in science is ultimately measured. The creativity of imagination which it requires is very close akin to that which contributes to genius in any other field of endeavor, such as literature, music, or the graphic or plastic arts, and is a gift or talent which can be cultivated and developed but cannot be acquired by merely being learned.

Nevertheless, if the scientist were to be content with merely formulating his hypothesis without testing it, then no matter how brilliant his hypothesis might be, it would remain a mere speculation with no real scientific worth. The method of confirmation of the hypothesis thus is as important as the hypothesis itself.

The method of confirmation of the hypothesis in contrast to the method of formulating a hypothesis, requires no special genius and is for that reason public, and freely available to any one who trains himself to think logically and to calculate, observe and measure carefully and exactly.

## THE CONFIRMATION OF THE HYPOTHESIS

Since the scientific hypothesis is a universal (even if only in the pragmatic sense of a "general" with a certain degree of probability), it cannot be directly confirmed by empirical means.

The techniques of formal *a priori* science (logic or mathematics) are enlisted therefore as the first step in the confirmation of the hypothe-

sis, namely, the formal *a priori deduction* of a *prediction* which is a logical consequence of the hypothesis and which is testable by empirical observation. Obviously, the prediction to be testable must be the statement of a *particular* rather than a universal. The simplest type of formal prediction consists of deriving the subaltern particular proposition from its corresponding universal by immediate inference—e.g., if all S's are P's, then sample $S_1$ is a P; or if no S's are P's, then sample $S_1$ is not a P. At the highest level of scientific achievement is a prediction derived through mathematical computations which leads to the discovery of new observable scientific facts such as the Einstein effect cited above. One of the supreme achievements of this formal phase of scientific genius was the calculation by Leverrier and Adams simultaneously, by means of which they were able to predict the existence and location of the hitherto undiscovered planet Neptune. The greatness of this prediction, of course, has been overshadowed by the recent developments in nuclear physics which led to the prediction and discovery of the atomic bomb. But as this subject is not only very hush hush, and completely beyond my grasp, I will merely suggest that for those who are familiar with these developments there is perhaps no better example of how far formal mathematical deductive science can take us in predicting not only where we should look, but what we shall find when we do so.

The terms hypothesis, theory, and law, which were mentioned in our preliminary tentative working definition of science, despite their apparent self-intelligibility, are rarely understood properly. We will conclude this paper, therefore, by distinguishing briefly between the meanings of these terms.

A hypothesis is a potential theory, or a potential law, depending on its degree of generality. Both the theory and the law are distinguished from the hypothesis in that they have been confirmed experimentally. While experimental confirmation distinguishes theory and law jointly from the hypothesis which is thus far unconfirmed, it is not the relative degree of confirmation which distinguishes as such the law from the theory. There does seem to be a widespread popular misconception that a theory is a partially and relatively scantilly confirmed hypothesis, that is, one which has been confirmed to a relatively lower order of probability, while a law is a theory which has received so much wider and more extensive and more adequate experimental confirmation that it has been confirmed to such a high degree of probability that it has the rank in *truth value* of a "law of nature."

In a coincidental fashion this distinction may actually hold, but it is relatively not crucial or necessarily true. Actually, the distinction between theory and law is simply an expression of the relative degree of *generality* or *universality* of the hypothesis from which either the theory or the law is derived. A hypothesis of a low order of generality, when confirmed, becomes a theory. A hypothesis of a high order of generality, when confirmed, becomes a law. The distinction between theory and law is quite broad and flexible, and as there are innumerable differences in the level of generality of hypotheses, there is no sharp line of demarcation between a theory of a relatively high degree of generality and a law of relatively low degree of generality. When the term law is used to designate a particular confirmed hypothesis, it is properly used primarily to emphasize the fact that the initial hypothesis is so vast in its generality that with its aid we can account for an enormous number of facts and with its aid we can derive and confirm and integrate an enormous number of hypotheses and theories of lesser generality. In this manner the law serves as the basic foundation on which a tremendous pyramid of further scientific achievement is constructed—the classic examples being Darwin's law of natural selection through the survival of the fittest, Mendel's laws of heredity, Newton's laws of motion and gravitation, the laws of conservation of energy and matter, and so forth.

The overwhelmingly successful character of the scientific enterprise makes it easily possible for us to become too enthusiastic in our estimate of the truth-value of the laws that we have discovered. One of the basic presuppositions of all science is that the natural world is governed by order and that there are laws in the absolute sense which determine this order and that man with his finite powers can through science discover what these laws are. This faith, while it is an inevitable part of the equipment of a scientist, is actually more closely akin to religion in its character than to science—and when the scientist equates the finite, tentative, merely probable rules of order that he has discovered with the infinitely complex order that rules nature, he can do so only through an act of sheer faith.

116 SOUTH MICHIGAN AVE.
CHICAGO, ILLINOIS

---

# MECHANISMS SUBSERVING SIMULTANEOUS BRIGHTNESS CONTRAST*‡

Glenn A. Fry†
School of Optometry, Ohio State University,
Columbus, Ohio

## INTRODUCTION

In previous papers[1, 2, 3] dealing with brightness contrast borders, the writer has proposed that many of the phenomena associated with such borders are dependent upon interaction between retino-cortical pathways. This paper presents a hypothesis concerning the nature of the interaction.

## CORRELATES OF BRIGHTNESS

In order to formulate the problem, it is assumed that at any level in one of the pathways from the retina to the brain, the frequency of impulses is the variable which is the counterpart of brightness in the introspective world and the counterpart of retinal illuminance in the physical world. Also one can identify a given pathway as associated with a given region of the retina and speak of a distribution of frequencies in the retino-cortical pathways in the same sense as a distribution of illuminance on the retina. Since adjacent pathways may respond at different frequencies, it is probably better to speak of the average frequency in a given region.

## GENERAL STATEMENT OF THE HYPOTHESIS

Two different types of mechanisms of interaction must be involved. One is strictly a mechanism for inhibition. It can be described simply by saying that the inhibition initiated by stimulation of any point of the retina reduces the frequency of impulses transmitted through the retina both at the point in question and in adjacent regions, with the effect waning as the distance increases. The second is a frequency-equalizing mechanism which makes adjacent pathways respond at about the same frequency (but not necessarily in synchronization) so as to wash out

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 15, 1947. For publication in the April, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Fellow, American Academy of Optometry. Director, School of Optometry, Ohio State University.

‡Aided by a grant-in-aid for research in Physiological Optics by the Bausch & Lomb Optical Company.

minor differences in brightness across the field of view. At brightness contrast borders, the mechanism either washes out the impression of the border entirely, or tends to make the fields on both sides of the border uniform up to the border.

For clarity of exposition, if for no other reason, it is assumed that the inhibiting mechanism is located at a very low level in the retino-cortical transmission system, and presumably involves only the receptors and bipolar cells. At a higher level the frequency-equalizing mechanism involving interaction at synapses imposes further modifications upon the impulse frequencies in the retino-cortical pathways. This sort of mechanism is probably duplicated at each synapse at which interaction can occur. For example, the operation of such a mechanism at the cortical level might account for the importance of borders in binocular rivalry and fusion.[3]

Actually so far as the final outcome is concerned, it is immaterial (1) whether the mechanism of inhibition is electrical in character as has been proposed by Granit[4, 5, 6] and by Schouten and Ornstein[7], or (2) whether it involves lateral neurological connections such as provided by the horizontal cells, or (3) whether it involves a diffusion of some substance from one region of the retina to another, or (4) whether it involves a combination of mechanisms. One must also consider the fact that oscillating and scanning movements of the eye cause the image of a point source to stimulate in turn a number of photoreceptors and this might reduce appreciably the concentration of photosensitive substance in the photoreceptors stimulated.

The electrical type of mechanism has the advantage in that it must be located in the retina and because it does not presuppose any neural connections between the retino-cortical pathways. The electrical type of mechanism also has the advantage of rapid action, which would not be expected with the diffusion of a substance from one part of the retina to another. Furthermore it requires no eye movements.

## EXPERIMENTAL EVIDENCE FOR AN ELECTRICAL MECHANISM OF INHIBITION

A good bit of evidence has been accumulated in recent years in support of an electrical mechanism of inhibition in which electrical potentials between the retina and the back surface of the eye generated by the response of the retina to light exert an inhibitory influence upon the response of the ganglion cells at the point of the retina in question, and also in adjacent regions. The ganglion cell response is the

one measured; the bipolar response which precedes may be the one primarily affected.

To start with Granit[4] was able to analyze the electrical potentials generated by a flash of light into three components. After eliminating two of the components, the third component can still be induced by a flash of light and it is not accompanied by any activity in the optic nerve. Because the third component has a latent period, it cannot be associated with the photochemical reaction of the photoreceptors, and because it fails to overshoot at the onset of the stimulus, it probably is not likely associated with the discharge of impulses in the photoreceptor axons.

Granit[5] deduced that the third component exerts an inhibitory influence since the optic nerve response shows a new burst of activity when the third component dies down after the cessation of a stimulus. Furthermore, Granit[6] has shown recently that the frequency of response of a ganglion cell axon recorded with a micro-electrode can be enhanced or inhibited by causing a galvanic current to flow through the eyeball. Inhibitory and enhancing effects produced by galvanic currents have also been demonstrated subjectively.[7]

## FORMULAS FOR THE INHIBITING POTENTIALS

Let us assume as a basis for the hypothesis that stimulation of an element of area (dA) at a given point (Q) on the retina (See Fig. 1) with a given intensity of retinal illuminance (I) sets up an electrical field in which the potential difference (dE) at P at a distance (r) from

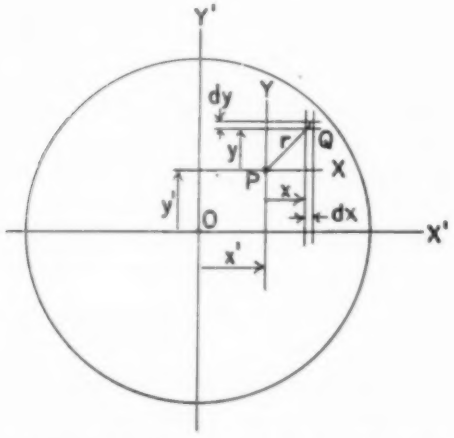



Fig. 1

Fig. 1. Analysis of inhibition in the retina. The circle represents the outline of the image of the test object.

Q is some function of r. The exact character of this function is not known. To illustrate the hypothesis let us assume that:

$$dE = k_1 I_Q dA\, e^{-\frac{r^2}{2\sigma^2}} \qquad (1)$$

The symbol, e, represents the base of the system of natural logarithms; $k_1$ and $\sigma$ are constants. A plot of Equation (1) is shown in Fig. 2.

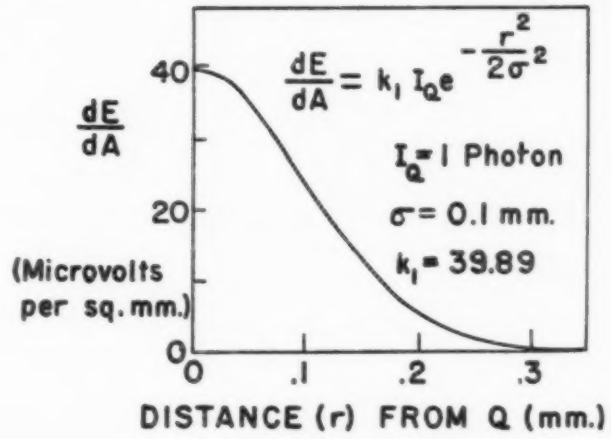



Fig. 2

Fig. 2. Values of $\frac{dE}{dA}$ for a single photon at various distances from Q.

An equation for the total potential difference E at P produced by all the elements of area surrounding P is obtained by letting P be the center of a coordinate system and the point Q any point with coordinates, x and y. Hence, dA is equal to dy dx, and

$$r^2 = x^2 + y^2, \qquad (2)$$

and

$$E = k_1 \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} I(x,y) \left(e^{-\frac{x^2}{2\sigma^2}}\right)\left(e^{-\frac{y^2}{2\sigma^2}}\right) dy\, dx\,. \qquad (3)$$

The constant, $\sigma$, expresses the extent of the region which contributes to E at the point P. Some notion as to what value ought to be assigned to $\sigma$ can be obtained from a consideration of the phenomenon which has been called metacontrast by Stigler[9], but which was ob-

served previously by McDougall[10] and Sherrington[11] and perhaps others.

A quantitative investigation of this phenomenon was undertaken by Fry[12] who used a stimulus pattern consisting of three concentric

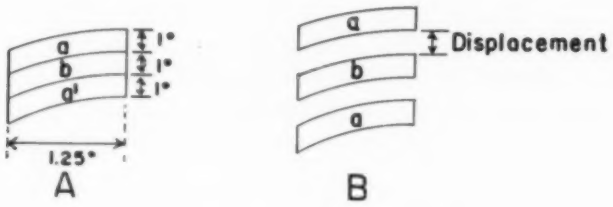



Fig.3.

Fig. 3. Stimulus pattern for the study of metacontrast.

annular segments a, b, and a′ as shown in Fig. 3A. When b is exposed prior to a and a′ by an interval ranging from 0 to 125 milliseconds the duration of a and a′ must be much shorter than the duration of b (4 milliseconds) in order for the three stimuli to appear equally bright. When the interval is greater than this the appearance is complicated by phi-movement and it is difficult to make judgments as to comparative brightness.

By alternating this group of stimuli with a fourth stimulus c, Fry was able to compare a, b, and a′ with c, and showed that a and a′ inhibit b and are not enhanced by b.

Fry[12] also investigated the effect of varying the distance of a and a′ from b as shown in Fig. 3B and found that the inhibition exerted by a and a′ on b gradually decreases and disappears when the angular displacement is greater than 1.25°.

On the basis of this experiment a value of .1 mm. has been assigned to $\sigma$, which corresponds to a visual angle of 23 minutes.

Let us assume that the process generating the inhibiting potential occurs at a point in the pathway through the retina which is more peripheral than the processes which are inhibited. This makes the amount of inhibiting potential generated by one pathway independent of the inhibiting potentials generated by adjacent pathways.

## THE EFFECT OF INHIBITING POTENTIALS ON FREQUENCY OF IMPULSES

The effect of the inhibiting potential E upon the frequency of impulses in the bipolar cells may be formulated as follows:

$$F = F' + k_2 \log \rho. \qquad (4)$$

In this equation F represents the frequency after modification by

the inhibiting potential E; F′ represents the frequency as it would be when unimpeded by E; $k_2$ is a constant; $\rho$ is a function of E.

Schouten and Ornstein[7] have devised an experimental method which may be used for determining the relation of $\rho$ to E. They employed the stimulus pattern shown in Fig. 4, which consists of a bright

Fig. 4.

Fig. 4. Stimulus pattern used by Schouten and Ornstein.

half-disk (A) presented to the left eye on a dark field and a glare source (C) and a second bright half-disk (B) presented to the right eye on a dark field. The subjects were trained to converge their eyes to make the two half-disks come together to form a bipartite photometric field. The luminance of A was kept constant and the luminance (Y) of B was varied to match A, once ($Y_1$) when the glare source was turned off and again ($Y_2$) when it was turned on.

If it may be assumed that the impulse frequency of the bipolars corresponding to B is the same in the two situations,

$$F'_1 = F_2 = F'_2 + k_2 \log \rho, \tag{5}$$

and if it may be assumed that F′, at least for a medium range of intensities, is related to Y by the following equation,

$$F' = k_2 \log Y + k_3, \tag{6}$$

$$k_2 \log Y_1 = k_2 \log Y_2 + k_2 \log \rho. \tag{7}$$

This reduces to

$$\rho = \frac{Y_1}{Y_2} \tag{8}$$

Schouten and Ornstein showed that the following relationship holds between $\rho$ and the candlepower (C) of the glare source.

$$\rho = \frac{1}{1 + k_4 C} \tag{9}$$

They also showed that $\rho$ is independent of the luminance of the standard stimulus A.

There are reasons to believe that the effect of the glare source on the photometric match in the experiment of Schouten and Ornstein was not produced by potentials generated at the part of the retina on which the image of the glare source fell, but was in some way related to the stray light falling on the retina in the region of B. The effect on $\rho$ of varying the angular distance from B to C makes it appear that $\rho$ depends on the stray light falling in the region of B. The fact that the effect is obtained when the glare source falls in the blind spot further supports this hypothesis. The one fact which points in the opposite direction is that differential effects are obtained by transmitting beams of light through the sclera before and behind the margin of the retina.

So far as the present paper is concerned it would be immaterial whether the potentials are generated by the image of the glare source or the stray light falling in the region of B, except that it has been assumed on the basis of the metacontrast phenomenon that the electrical field generated by stimulation of a given part of the retina is effective only over a very limited region. The shortest angular distance between C and B used by Schouten and Ornstein was 2° and this is just on the outskirts of the region in which metacontrast operates.

The experiment designed by Schouten and Ornstein also involves possible complications from the role played by binocular rivalry.

However, for the purpose of further elaboration of the theory, it may be assumed that

$$p = \frac{1}{1 + k_5\, k_1\, I_Q\, dAe^{-\frac{r^2}{2\sigma^2}}} \qquad (10)$$

This equation expresses the relation between $\rho$ as measured at the point P and the illumination I falling on an element of area (dA) of the retina at Q at a distance (r) from P. The distance factor, $e^{-\frac{r^2}{2\sigma^2}}$ is based on the metacontrast phenomenon, but assuming r to be constant for the moment the equation becomes equivalent to Equation (9).

It is also assumed in accordance with the findings of Schouten and Ornstein that $\rho$ is independent of the level of illumination falling at P.

Since it has been assumed in Equation (1) that,

$$k_1 I_Q \, d\Lambda e^{-\frac{r^2}{2\sigma^2}} = dE,$$

$$\rho = \frac{1}{1 + k_5 \, dE}$$

It may also be assumed in the case of the potential (E) developed by a number of elements of area in the vicinity of P that,

$$\rho = \frac{1}{1 + k_5 \, E} \tag{11}$$

## COMPUTATION OF FREQUENCY DISTRIBUTIONS

For any given distribution of intensity on the retina one can compute the distribution of F values, by means of Equations (3), (4), (6), and (11). Since for a given pupil size, retinal illuminance is directly proportional to the luminance of a surface seen by the eye, Equation (6) may be rewritten as follows:

$$F' = k_6 \log 1p + k_7. \tag{12}$$

Equations (3), (11), and (12) may be combined to obtain a general equation for F.

$$F = k_8 \log \frac{1p}{1 + k_5 \, E} + k_7. \tag{13}$$

## APPLICATIONS OF THE HYPOTHESIS

### (a) MACH RINGS

We are now in a position to test the consequences of the hypothesis. The most remarkable thing about the hypothesis is that it provides a simple explanation of Mach's rings[18-19]. Although Mach's rings are

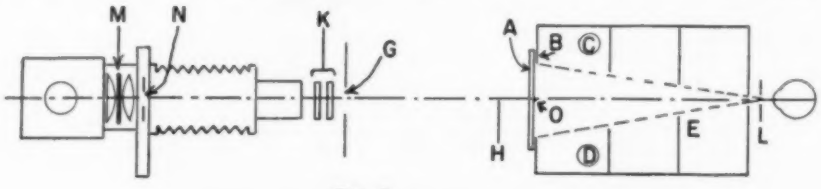



Fig. 5

Fig. 5. Apparatus for the study of Mach rings and other phenomena associated with intensity gradients.

usually demonstrated with rotating disks, they can also be demonstrated with the apparatus illustrated in Fig. 5.

The flashed surface of the piece of opal flashed glass (A) is held against the diaphragm (B). The aperture in this diaphragm subtends an angle of 3.6° at the artificial pupil (L) and constitutes the test object.

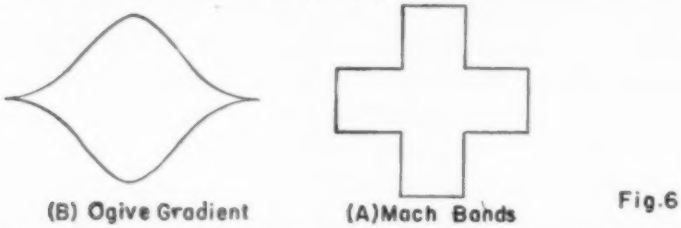



Fig. 6. Apertures for controlling the luminance gradient across the test object.

The artificial pupil (L), which is 2 mm. in diameter, makes it easy to specify the intensity of retinal illuminance in photons. The opal flashed

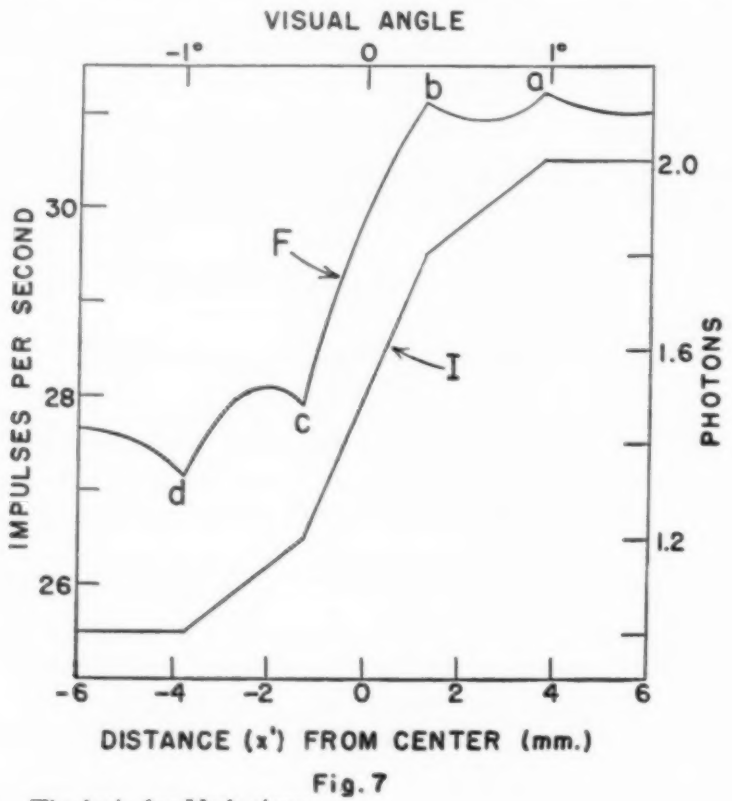



Fig. 7. The basis for Mach rings.

surface (A) is illuminated by the two sources, C and D, and also by the projection lantern which has a piece of ground glass (M) inserted between the two elements of the condenser. A diaphragm (N) with a circular aperture is placed in the slide holder. An image of this aperture is focused on the opal glass (A) and is larger than the aperture in diaphragm B. The amount of light reaching A from the lantern is controlled by the crossed polaroids at K. The screen H, which has a straight vertical edge on the right side, produces a shadow on the opal flashed glass. The penumbra of the shadow represents a graded distribution of intensity whose characteristics are determined by the shape of aperture at G.

When aperture at G has the shape shown in Fig. 6A, it is possible to produce a distribution of intensity at various points along the horizontal diameter of the retinal image of the test object such as that illustrated in Fig. 7. The symbol x′ represents distance from the center of the image of the test object. The striking thing about the appearance of this type of stimulus pattern is that bright Mach bands are seen at a and b and dark ones at c and d.

In Fig. 1, O represents the center of the image of the test object and the x′ and y′ axes represent the horizontal and vertical diameters. P represents any point (x′, y′) at which it is desired to compute the value of F. It is the center of a new coordinate system with x and y axes parallel to the x′ and y′ axes. Since for the type of distribution under consideration the value of I remains constant for all values of y for a given value of x, Equation (3) reduces to

$$E = 2.5066\ \sigma\ k_1 \int_{-\infty}^{\infty} I_x e^{-\frac{x^2}{2\sigma^2}}\, dx\,. \qquad (14)$$

With the aid of this equation and Equation 13, values of F have been calculated for the various values of x′. In making these calculations, E has been expressed in microvolts, I in photons, A in sq. mm., r, x, and y in mm., and F in impulses per second; also the following values have been selected for the constants:

$$\sigma = 0.1 \text{ mm.}$$
$$k_1 = 39.89$$
$$k_5 = 1$$
$$k_7 = 54.85$$
$$k_8 = 50$$

Although these values have been selected primarily to illustrate the hypothesis, they have some basis in fact, at least to the second significant figure.

The distribution of F values is shown in Fig. 7 along with the distribution of I values. The bright and dark Mach bands can be accounted for by the peaks and depressions in the F distribution.

(b) CONTRAST EFFECTS WITH OGIVE DISTRIBUTIONS

Another consequence of the hypothesis is that the inhibition mechanism in the retina accentuates the "contrast" at a brightness contrast border. No matter how sharp the transition across a brightness contrast border may be, the distribution of illuminance on the retina is graded because of the aberrations of the eye and other factors such as the rapid, fine oscillations of the eye which add to the blurredness. This condition of blurredness can be accentuated by starting out with a

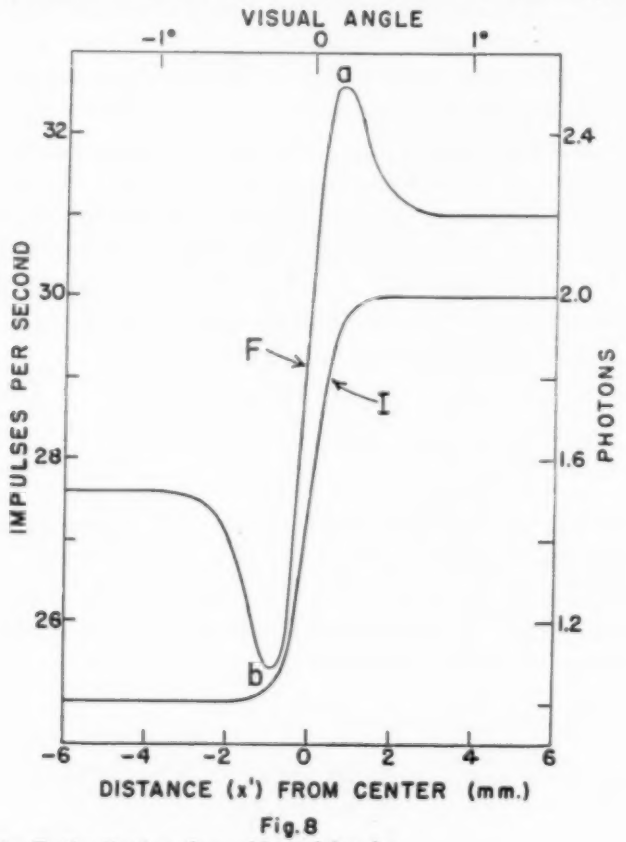



Fig. 8. The F-distribution for a blurred border.

blurred border in the stimulus pattern presented to the eye. By using an aperture at G which has the shape shown in Fig. 5B, one can produce a shadow with a blurred edge which gives an ogive distribution of retinal illumination (I) like that illustrated in Fig. 8. The corresponding distribution of F values is shown in the same figure. If the degree of blurredness is small, the subject sees a sharp contrast border separating the two halves of the test object, and each half appears to be uniformly bright up to the border. Although the mechanism of inhibition sharpens the contrast, it is necessary in addition to postulate a frequency-equalizing mechanism, which smooths out the frequency differences on each side of the border, and which determines at what point the border will be located.

As the blurredness is increased the sharp border breaks down and the distribution is perceived as graded. At one stage the observer can see broad bright and dark bands corresponding to the peak (a) and the depression (b) in the F-distribution.

(c) GRAY PATCHES ON BRIGHTER AND DARKER BACKGROUNDS

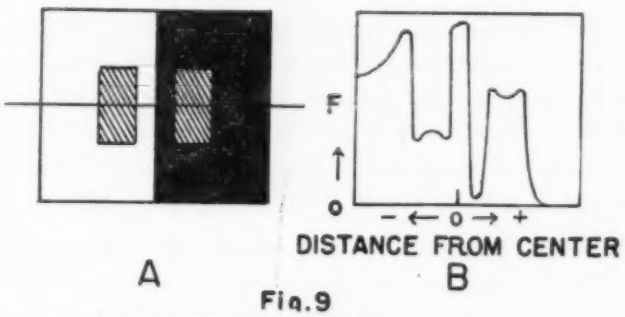



Fig. 9. Gray rectangles on bright and dark backgrounds.

In the case of a stimulus pattern like that shown in Fig. 9A consisting of gray rectangles of equal luminance placed on black and white backgrounds, each rectangle appears uniformly bright but the one on the dark background is brighter. What happens to the F-distribution in a horizontal direction across the center of the pattern is illustrated in Fig. 9B.

It is necessary to assume that a frequency-equalizing mechanism flattens out the frequency distributions for the two rectangles leaving one somewhat higher than the other.

By varying the luminance value of one of the rectangles it is possible to obtain a brightness match and thus measure "the amount of

contrast." It has been shown that increasing the width of the rectangles reduces "the amount of contrast." Furthermore, reducing the luminance difference between the two halves of the background also reduces "the amount of contrast." These facts are in line with what one might expect from the hypothesis proposed above.

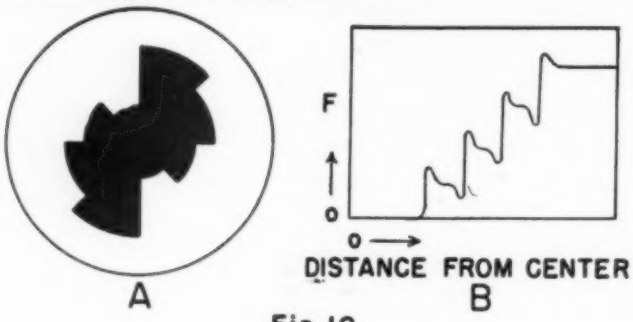



Fig. 10

Fig. 10. Disk for producing a stair-step distribution.

(d) CONTRAST EFFECTS WITH STAIR-STEP DISTRIBUTIONS

The frequency-equalizing mechanism is not always able to wash out the gradients produced by the mechanism of inhibition. When the disk in Fig. 10 is rapidly rotated, it produces the effect of a series of annuli which are progressively brighter from the center out. Each band is uniform in so far as the physical stimulus is concerned, but it appears much brighter at its inner edge than at its outer edge.

(e) INHIBITION AS A FORM OF ADAPTATION

Another consequence of the hypothesis is that the mechanism of inhibition provides a form of adaptation in that it permits the retino-cortical pathways to operate at reduced frequencies when the eye is exposed to high levels of luminance. In the case of a uniform surface of unlimited extent, Equation (3) reduces to

$$E = 2\pi \sigma^2 k_1 I. \qquad (15)$$

This equation may be combined with Equation (13) to give an equation for the frequency F for a uniform surface of unlimited extent. By assuming the same values for the constants as assumed in previous parts of the paper, values of F have been calculated for different levels of retinal illuminance and are plotted in Fig. 11. The most striking thing about this graph is that the frequency is constant for high levels of intensity. This is in agreement with the finding of Craik[20] that subjective brightness remains constant for high levels of retinal illumi-

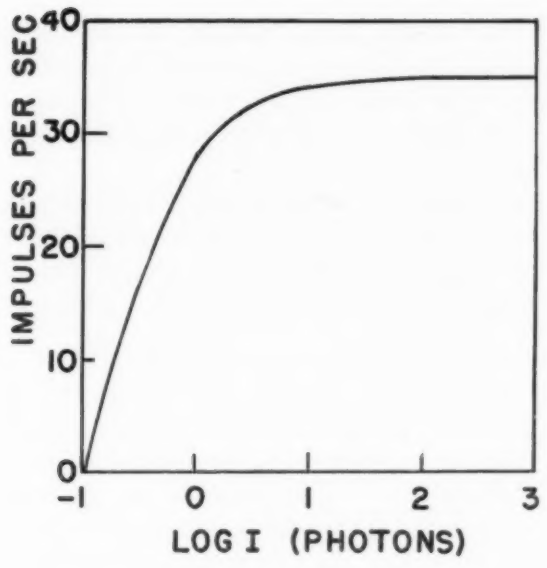



Fig.11

Fig. 11. Values of F for different levels of retinal illuminance in the case of a uniform extended surface.

nance, if time is permitted for the eye to become adapted to each level of illuminance.

In spite of the fact that the frequency might be constant for different levels of illuminance in the case of uniform surfaces, the mechanism of inhibition would make it possible to perceive brightness contrast borders and brightness differences in the case of a small dark or bright object on a uniform background; that is to say, the frequency would be depressed on the dark side of the border, and on the bright side of the border the frequency would be less depressed at the border than at some distance from the border.

## DEFECTS OF THE HYPOTHESIS

An obvious defect of the hypothesis is that it does not make adequate allowance for photochemical adaptation in individual photoreceptors. This deficiency is manifest in Equation (6) which can be assumed to hold only for a medium range of intensities. F′ would have to be dependent on concentration of photosensitive substance in the photoreceptor and at high intensities this concentration would have to approach a constant. At least this is the assumption which is made in

connection with the current photochemical theories of the photoreceptor response. If Equation (6) were modified to permit F′ to approach a constant value at high levels of illuminance, Equations (1) and (11) would have to be modified to provide for a constant value for F at high levels of illuminance.

Another weak point of the hypothesis is the assumption that the inhibiting potential produced by a stimulus is directly proportional to the intensity. This is most unlikely and it is to be expected that modification of this phase of the hypothesis will be called for in the future.

## THE ROLE OF EYE MOVEMENTS

In the case of prolonged fixation it is possible for eye movements to affect the state of photochemical adaptation of the photoreceptors in the region of a border in such a manner as to enhance the activity on the bright side of the border and depress it on the dark side. This factor can operate simultaneously with the mechanisms of interaction between retino-cortical pathways and contribute to the final result.

Eye movements alone, however, cannot account for all of the effects. The metacontrast phenomena are produced with momentary exposures which rule out effects of eye movements and photochemical adaptation. Furthermore, Mach rings are obtained with a momentary exposure.

## RELATION OF BRIGHTNESS TO COLOR CONTRAST

Some consideration must be given to the mechanism for transmitting responses to different chromatic stimuli through the retina and its relation to the mechanisms responsible for simultaneous brightness and color contrast. It might be supposed, somewhat in accord with McDougall's[21] version of the Young-Helmholtz theory, that three separate sets of photoreceptors and retino-cortical pathways are necessary to subserve color vision, and the inhibitory mechanism is duplicated for each fundamental color, and that the stimulation of, say, red receptors in one region of the retina will depress activity in red retino-cortical pathways in adjacent regions. This would account for color contrast. But this is ruled out by the fact that Mach rings cannot be obtained with a rotating disk like that illustrated in Fig. 12 when the star which is red has the same luminance as the background which is green[18, 19].

A theory of color contrast based on the modulation theory of color vision has been proposed in a previous paper[22] which involves inducing a modulation pattern in one area of the retina by modulation of the impulse frequency in retino-cortical pathways in an adjacent region.

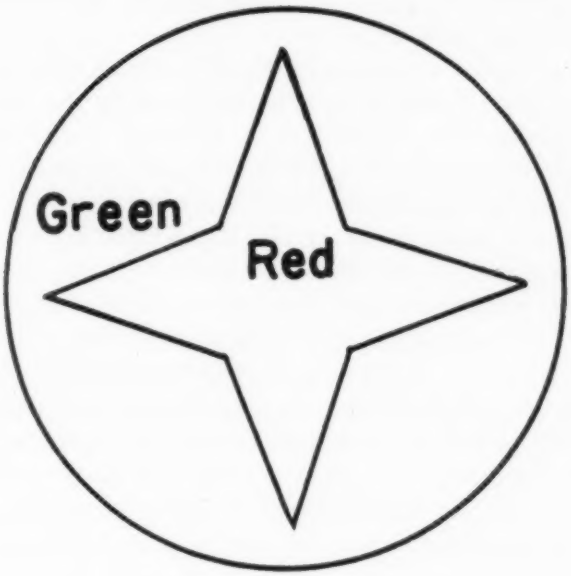



Fig. 12

Fig. 12. Disk for demonstrating the absence of Mach rings with a rotating star having the same luminance all over, but which has a chromaticity gradient.

The inhibitory mechanism outlined in this paper would be adequate to account for the induction of complementary modulation patterns. The rapid action of the inhibitory mechanism which would be required for such effects is demonstrable in connection with the metacontrast effects.

## SUMMARY

A hypothesis has been presented in an effort to tie together a number of facts relating to simultaneous brightness contrast phenomena obtained with various types of stimulus patterns, electrophysiological data relating to inhibition in the retina, metacontrast, Mach bands, and indirect adaptation.

It is proposed as a hypothesis that stimulation at any given point of the retina sets up an electrical field in which the potential difference between the front and back of the retina gradually decreases as the distance from the point of stimulation increases. The potentials produced at any given point by stimulation of a number of surrounding points are additive. The potential at any given point reduces the frequency of impulses transmitted through the retina at that point. The net

result of these inhibitory effects is to modify the distribution of frequencies in the retino-cortical pathways.

It is also proposed as a part of the hypothesis that a frequency-equalizing mechanism operates at a higher level in the retino-cortical pathways to equalize the frequencies in adjacent pathways except at contrast borders; at such borders the mechanism tends to smooth out the frequencies on the two sides of the border.

A quantitative formulation of the hypothesis is presented which is based upon metacontrast phenomena and effects of indirect adaptation.

It is shown how the Mach bands can be predicted from the hypothesis as well as ordinary simultaneous contrast phenomena.

The mechanism of inhibition proposed provides a form of adaptation in that a number of retino-cortical pathways stimulated within a given region force each other to operate at reduced frequencies.

Other mechanisms of inhibition, such as diffusion of a chemical substance from one part of the retina to another, nerve connections between retino-cortical pathways, and eye movements, have been considered.

The relation of brightness contrast to color contrast also is discussed.

REFERENCES

1. G. A. Fry and V. M. Robertson, Am. J. Psych., 47, 644-655 (1935).
2. G. A. Fry, J.O.S.A., 37, 166-175 (1947).
3. G. A. Fry, Archives of Ophth., 15, 443-456 (1936).
4. R. Granit, J. of Physiol., 77, 207-233 (1933).
5. R. Granit, J. of Physiol., 83, 359-381 (1935).
6. R. Granit, J. of Physiol., 105, 24-37 (1946).
7. J. F. Schouten and L. S. Ornstein, J.O.S.A., 29, 168-182 (1939).
8. S. V. Kravkov and L. P. Galochkina, J.O.S.A., 37, 181-186 (1947).
9. R. Stigler, Handbuch der biologischen Arbeitsmethoden, Abt. 5, Teil 6 (2 Halfte), 949-968 (1937).
10. Wm. McDougall, Brit. J. of Psych., 1, 78-113 (1904-05).
11. C. S. Sherrington, J. of Physiol., 21, 33-54 (1897).
12. G. A. Fry, Am. J. of Physiol., 108, 701-707 (1934).
13. E. Mach, Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe (Wien) (II) 52, 303-322 (1865).
14. E. Mach, Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe (Wien) (II) 54, 131-146 (1866).
15. E. Mach, Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe (Wien) (II) 54, 393-408 (1866).
16. E. Mach, Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe (Wien) (II) 57, 11-19 (1868).
17. Wm. McDougall, J. of Physiol., 29, xix-xxi (1903).
18. R. H. Thouless, Brit. J. of Psych., 13, 301-307 (1923).
19. K. Koffka and M. R. Harrower, Psychologische Forschung, 15, 145-275 (1931).
20. K. J. W. Craik, Proc. Roy. Soc. Lon., 128-B, 232-247 (1939-40).
21. Wm. McDougall, Mind, 10, 347-382 (1901).
22. G. A. Fry, J. Exp. Psych., 57, 789-804 (1934).

# REPORT ON A FAMILY WITH SUB-LUXATED LENSES*

Simon Sculler†
Columbus, Ohio

An examination of the available records provides case reports on individuals and families demonstrating ectopic lens problems where the suspensory ligament fibers blocked the space around the crystalline. None of the reports the writer read included patients with sub-luxation of the crystalline, where the space around the crystalline was open for use and free of suspensory ligament fibers. The family the writer is reporting here falls into the latter group.

The first of the cases covered here, Miss R. C., age 17, came to the writer's office for refraction February 2, 1946. At that time she was wearing:

O. D. —12.00 D. Sph. ⌒ —2.75 D. cyl. x60 V. A. = 20/400
O. S. —12.00 D. Sph. ⌒ —2.75 D. cyl. x105 V. A. = 20/400

The ophthalmoscopic examination was negative with only one exception, the crystalline lenses were displaced temporal and superior, leaving crescent-shaped openings formed by the margin of the lenses and the inner edge of the irises. There were no suspensory ligament fibers present in the open spaces. See Figure 1.

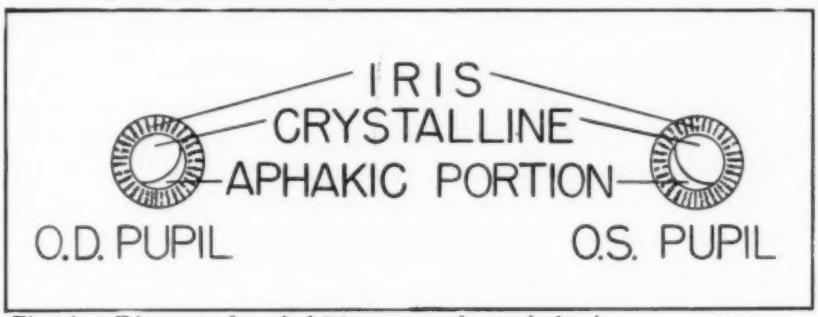



Fig. 1. Diagram of typical appearance of ectopia lentis.

The refraction with minus lenses (rays passing through the crystalline) showed:

O. D. —13.75 D. Sph. ⌒ —2.50 D. cyl. x90 V. A. = 20/300
O. S. —14.75 D. Sph. ⌒ —1.25 D. cyl. x90 V. A. = 20/300

*Submitted on December 18, 1947, for publication in the April, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist.

Reading with this or her original correction was accomplished at 3 inches by sliding the page across her nose, and it proved to be a very slow process. The patient had managed to keep up with her class in school in spite of her handicap and she graduated from high school in June, 1946.

The writer's next attempt was based on the idea of using the space between the crystalline and iris. This produced the following:

O. D. +9.25 D. Sph. ⌒ +1.25 D. cyl. x90 ⌒ +5.00 D.
Add V. A. = 20/30.

O. S. +9.75 D. Sph. ⌒ +1.75 D. cyl. x105 ⌒ +5.00 D.
Add V. A. = 20/30.

With this prescription she showed 20△ esophoria and 6△ right hyperphoria, and diplopia which the patient could overcome by the application of a full-correcting prism as stated above followed by gradual reduction of both prism components to zero. Although the above prescription appeared to be a "full" correction for distance, it required a +5.00 add O. U. to produce easy reading ability at 10 to 11 inches.

The plus correction was made up and put on the patient May 8, 1946. On May 17, a progress report showed diplopia with rare intervals of single binocular vision at reading distance. On May 29, the diplopia occurred at rare intervals and only in distant vision. The phorias were 3△ esophoria and 5△ right hyperphoria. On June 17, the patient reported constant, single, binocular vision at all distances. The prescription was ordered in a No. 2 shade soft-lite but was made up in "white" lenses. While wearing this correction the patient reported total loss of vision lasting for several minutes on emerging from shade to bright sunlight. When she wore the same prescription in a No. 2 tint, she reported no recurrence of this problem which was caused by a contraction of the pupil closing up the space around the crystalline.

This patient came to the writer's office looking for "thin" lenses. Her present correction is far from thin. After suggesting the possibility of contact lenses and since she liked the idea, the writer did a refraction with contact test lenses. The findings:

O. D. 12/7.5 Nupuf test lens ⌒ +5.00 D. Sph. at 21 mm. Contact lens displaced 3 mm. down at 315°. V. A. = 20/25,

O. S. 12/7 Nupuf test lens (no add), contact lens displaced 3 mm. down at 225°. V. A. = 20/25.

When the patient was informed as to the fees for contact lens fitting, she lost interest in the idea.

The mother of this first patient, G. T. C., age 41, came to the writer's office for refraction March 28, 1946. The ophthalmoscopic findings were negative except for a marked sub-luxation O. U. but not to the extent that the writer could plan to use the open space for vision. The prescription was:

O. D. —1.00 D. Sph. ⌒ —1.00 D. cyl. x30. V. A. = 20/60+2.
O. S. —1.00 D. Sph. ⌒ —1.25 D. cyl. x150. V. A. = 20/60+4.

Next in the group came the sister of the first patient, Miss B. C., age 12, whom the writer saw for refraction on October 23, 1946. In her case the ophthalmoscopic findings were all negative (no visible evidence of sub-luxation). The prescription was:

O. D. +1.00 D. Sph. ⌒ —1.00 D. cyl. x180. V. A. 20/30.
O. S. +1.00 D. Sph. ⌒ —1.50 D. cyl. x180. V. A. 20/30+4.

Since there was no evident cause for the subnormal visual acuity the writer is inclined to think that it is due to a small amount of sub-luxation.

On January 16, 1947, the writer saw Miss L. T., age 63, for refraction. She reported that she had been operated on in 1908 by a Dr. Marshall of Portsmouth, Ohio, for excision of a portion of the iris to provide better vision. She reported that this helped for about 20 years. She had "infection" O. D. in the summer of 1946. Ophthalmoscopic findings: pupils displaced down to limbus, O. D. dense corneal scars, O. S. crystalline displaced and attached to retina covering fovea; old, inactive choroiditis. Refraction:

O. D. no vision;
O. S. wearing +2.75 D. Sph. ⌒ —2.00 D. cyl. x135.
V. A. 20/400 minus (no change of lens produced any improvement).

On February 10, 1947, the writer saw a Miss M. G., age 46, for refraction. She described a sudden change in vision O. D. which occurred in May, 1946, and reported constant diplopia with occasional triplopia (monocular diplopia O. S.). Ophthalmoscopic findings:

O. D. Crystalline resting on floor globe;
O. S. Sub-luxation crystalline displaced superior and temporal as in Figure 1.

She was wearing glasses made for her in June, 1946, as follows:

O. D. +8.00 D. Sph. ⌒ +3.00 D. add.
O. S. +8.00 D. Sph. (no add).

It was with this Rx that she saw triple. The writer's refraction indicated the following prescription:

O. D. +9.00 D. Sph. ⌒ —1.25 D. cyl. x135, add +2.75 ⌒ 10△ In. V. A. = 20/25.
O. S. +10.25 D. Sph. ⌒ —1.50 D. cyl. x90 ⌒ 3△ Up, add +2.75 ⌒ 3△ Up. V. A. = 20/40.

This correction produced single binocular vision in all but bright light where the pupillary contraction to light cut off the aphakic area O. S. and a dim secondary image put in its appearance. The formula above could not be produced in any present day bifocal, yet the nature of the patient's work required vision at both far and near at all times. The writer ordered the following prescription:

O. D. + 9.00 D. Sph. ⌒ —1.25 D. cyl. x 135 ⌒ 6△ 135°, add +2.75 ⌒ 3△ In.
O. S. +10.25 D. Sph. ⌒ —1.50 D. cyl. x90 ⌒ 3△ In ⌒ 3△ Up. Slab-off, add + 2.75 ⌒ 3△ In. #2 shade soft-lite.

The glasses were completed and put on the patient May 1, 1947. At a progress check on June 2, the patient reported diplopia O. S. in all but dim light, fusion of bright image O. S., and the O. D. image in dim light. On August 19, the patient's report was the same as on June 2, but she complained that O. S. was more hindrance than assistance. V. A. was improved by blocking off O. S. No change was made at that time. On September 2, 1947, refraction indicated the same sphere and cylinder findings but no prism in distance and only 4△ In for near. The prescription was as follows:

O. D. + 9.00 D. Sph. ⌒ —1.25 D. cyl. x 135, add +2.75 ⌒ 2△ In.
O. S. +10.25 D. Sph. ⌒ —1.50 D. cyl. x 90, add +2.75 ⌒ 2△ In. #2 soft-lite.

These glasses were put on the patient October 21, 1947, and at the present time she is getting single binocular vision in all but bright sunlight. The writer cannot account for the fact that the pupil O. S. remains large enough to permit use of the aphakic portion of the eye with the present correction when it did not with the last.

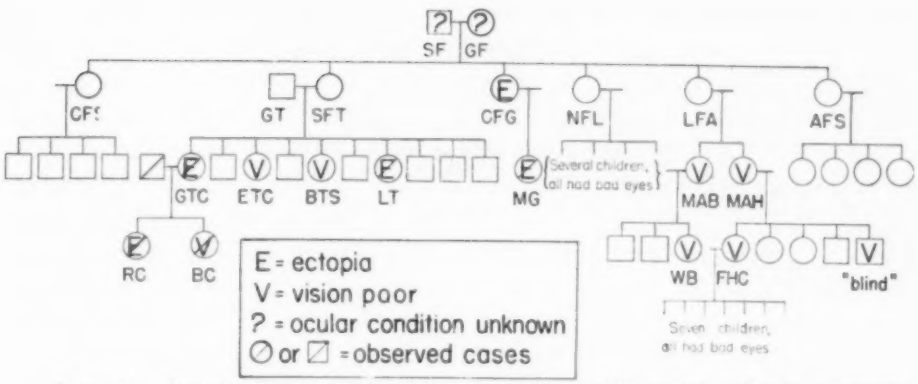



Fig. 2. Genetic diagram of cases discussed in this paper. Circles represent females; squares represent males. Cases marked with a diagonal line were seen by the writer.

The genetic diagram, Figure 2, has been drawn from the reports given the writer by G. T. C. and M. G.

The assistance of Dr. Henry W. Hofstetter in locating references and in preparation of this paper is gratefully acknowledged.

33 NORTH HIGH STREET
COLUMBUS 15, OHIO

REFERENCES

Adams, P. H., Trans. Ophth. Soc. United Kingdom, 1909, V. 29, p. 274.
Burch, F. E., Arch. of Ophth., 1936, V. 15, p. 645.
Cameron, E. P., British Journal of Ophth., 1926, V. 10, p. 384.
Falls and Cotterman, Arch. of Ophth., 1943, V. 30, p. 610.
Lewis, G. G., Arch. of Ophth., 1904, V. 33, p. 275.
Von Graefe, A., Arch. of Ophth., 1854, V. 2, p. 255.

ABSTRACT

CONTACT LENS FOR OCCLUSION. John C. Neill. Alumni Bulletin, Pennsylvania State College of Optometry. 1.7.5-6. 1947.

The author finds that there is an occasional need for a contact lens of the prosthetic type made completely opaque to light. No such plastic lens now exists. To fill this need the usual prosthetic contact lens (painted iris, pupil, blood vessels, etc.) is first made and fitted to the patient's eye. The interior of this lens is then coated with white lacquer. Then, after this has dried thoroughly, it is again coated with black lacquer. The second coat is also allowed to dry thoroughly and then is lightly buffed to insure smoothness. Before the finished lens is inserted into the eye the lens is immersed in a solution of phemerol for several hours to remove any traces of the lacquer solvent. The finished lens will be completely opaque to light and the white lacquer will prevent the black from showing through the translucent plastic. The author presents a case report in which an opaque contact lens is used.

C. C. K.

AMERICAN JOURNAL OF OPTOMETRY
*and* ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY
Established 1924

Vol. 25 APRIL, 1948 No. 4

EDITORS AND STAFF

Dr. Carel C. Koch . . . . . *Editor*
Dr. Robert E. Bannon . . . . . *Research Editor*
Virginia Huck . . . . . *Editorial Assistant*
Joseph G. Majersky . . . . . *Editorial Assistant*
Harry Brookins . . . . . *Production Manager*
William H. O'Brien . . . . . *Advertising Manager*
Mary L. Kerr . . . . . *Circulation Manager*

Publication and Academy Office: 1502 Foshay Tower, 821 Marquette Ave. Minneapolis 2, Minnesota

Annual Subscription, $5.00 in Advance; Canada, $5.50; Foreign, $6.00; Single Copies, 50c.

Original papers, scientific communications, clinical reports, books for review, and correspondence should be sent to the editor. Subscriptions and applications for single copies should be addressed to the circulation manager. Copy of advertisements must be sent in by the first of the month preceding their appearance. Communications with reference to advertising or other journal business should be addressed to the advertising manager. Academy correspondence should be addressed to Dr. Carel C. Koch, Secretary of the American Academy of Optometry.

Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

## AN EXAMPLE OF THE METHOD OF SCIENCE*

At the annual meeting of the American Academy of Optometry at which the "Method of Science,"[1] was presented, another paper called "Mechanisms Subserving Simultaneous Brightness Contrast"[2] was also presented. The latter paper dealt with relationships so complex that practically all of the principles outlined in my paper, "The Method of Science," were employed in formulating and testing the hypothesis. No claim is made that the hypothesis is true or false. It is used as an example in this editorial simply because it illustrates the use of the principles outlined by the writer.

In order to gain a full appreciation of the various steps in the development of the hypothesis, it is necessary to refer back to the refer-

*By Dr. Eugene Freeman, Chicago, Illinois. Fellow, American Academy of Optometry.

ences cited in Fry's paper. These references describe the facts which Fry's hypothesis attempts to tie together.

For example, we have the numerous observations made by Mach, McDougall, Thouless, Koffka, and Harrower on Mach rings. These writers attempted to relate the various aspects of this phenomenon to each other by showing the variations in the phenomenon which occur when the stimulus pattern is altered in different ways. Thus, these writers went beyond the mere stage of random, unsystematic, and unselected observations and described and arranged these facts in systematic order which represents the second step in the method of science.

McDougall went on to the third step and asked what relationship existed between this phenomenon and the ordinary phenomenon of simultaneous contrast which had been previously observed and described by other observers. He was also aware of the anatomy of the retina and retino-cortical pathways and raised the question whether there could be any relationship between the phenomenon of simultaneous contrast and phenomena of reciprocal enhancement and excitation which occur in the spinal cord. McDougall went one step further in formulating a hypothesis known as the drainage hypothesis which would account both for facts of simultaneous contrast and reciprocal inhibition and excitation in the spinal cord. The principles of this hypothesis led to certain predictions which could not be confirmed and the theory has been abandoned.

Another type of observation is that made by Sherrington on the interaction of intermittent stimuli applied to adjacent regions of the retina. Related phenomena have also been observed by McDougall, Stigler, Fry, and others, and these investigators in the course of time have managed to describe and arrange the phenomena into a systematic classification.

Many investigators have observed and described ordinary simultaneous contrast phenomena and these descriptions and classifications have come to be accepted as a part of the accumulated facts of science.

Using electro-physiological methods, Granit and others have observed, described, and classified phenomena which relate to inhibitory effects in the retina associated with electrical potentials.

Fry called attention to these observations and arranged them for the purpose of pointing out possible relations between them. This process of arranging is an unfactual procedure and its goodness or badness cannot be confirmed by direct observation. Whether good or bad, the arrangement of the facts led to a conception of specific mechanisms

underlying the relationships. The postulation of the existence of, and the description of, these mechanisms constitutes Fry's hypothesis.

His hypothesis like any hypothesis is a tentative conjectural solution of the problem. The mechanism he has described cannot be observed directly. Its existence can only be postulated and has to be demonstrated indirectly. The hypothesis can never be fully tested nor fully validated by experiments. Although one cannot hope to establish the truth of the hypothesis, he may be able to demonstrate its usefulness. In attempting to establish the usefulness of the hypothesis, one has to state particular logical consequences or direct applications of the hypothesis in the form of predictions which can be tested by controlled observation and then make the observational tests of the predictions. Fry has outlined in his paper a number of specific predictions of his hypothesis and has pointed out results which he claims verify his predictions. Only a finite number of predictions and empirical tests can actually be made and hence the solution to the problem is only partial and tentative although the hypothesis itself is universal in its formulation.

As pointed out in my paper, "The Method of Science," the primary requirement of a good hypothesis is that it must be capable of independent observational verification. That is to say, the hypothesis must incorporate the description of a mechanism or a principle which will lead to predictions that can be tested. This principle is illustrated in Fry's hypothesis inasmuch as definite mechanisms are proposed which must produce a variety of effects that can be tested.

The second characteristic of a good hypothesis is that it must be useful in predicting facts which have not as yet been observed. This principle is illustrated in connection with the bright and dark bands obtained with the ogive distribution, which were actually predicted by the hypothesis before ever being observed.

The third characteristic of a good hypothesis is that it must be in agreement with the accepted results of science. As pointed out earlier it is not possible to examine the hypothsis in relation to all possible facts but it should not be in conflict with any known fact. In this connection it is necessary to suspend judgment of Fry's hypothesis until a more quantitative evaluation of the facts is made.

A new hypothesis also helps with the advance of science if it leads to predictions which when confirmed will also disconfirm conflicting theories which are currently kept under consideration. In this connection Fry has considered the theory of diffusion of a chemical substance

from one part of the retina to another. This specific type of mechanism is not fast enough to account for some of the effects which are obtained and which are predicted by his hypothesis. The same objection is raised to the eye movement theory.

What is the relationship between Fry's hypothesis and theory and law? If we differentiate between law and theory on the basis that law has a much higher degree of generality and universality than theory, it is obvious that if Fry's hypothesis is finally established or generally accepted as plausible, it is more likely to be regarded as a theory than as a law. Fry's mechanism is a collection of more basic mechanisms, and it is a collection of mechanisms peculiar to the eye.

A *theory* of simultaneous contrast might be contrasted to the Bunsen-Roscoe law of photo-chemistry which applies not only to the eye but to photo-chemical reactions in general, or the all-or-none law of nerve conduction which operates not only in the eye but for all nerve fibers as well as non-living mechanisms of the same type.

It is not right to think of Fry's hypothesis as an established theory because the tests made so far are only qualitative and preliminary. Much more thorough quantitative tests can be made. If after all these possibilities have been milked, the hypothesis is not disconfirmed or superseded by a more adequate hypothesis, it may come to be regarded as a proved theory, that is, proved to be useful, not proved to be true.

EUGENE FREEMAN

116 SO. MICHIGAN AVE.
CHICAGO, ILLINOIS

REFERENCES

1. Eugene Freeman. The Method of Science. Am. J. Optom. and Arch. Am. Acad. Optom., 25, 4, 153-161, 1948.
2. Glenn A. Fry. Mechanisms Subserving Simultaneous Brightness Contrast. Am. J. Optom. and Arch. Am. Acad. Optom., 25, 4, 162-178, 1948.

## ABSTRACT

INTERPROFESSIONAL RELATIONS IN CASES OF OCULAR PATHOLOGY. E. LeRoy Ryer and Elmer E. Hotaling. Rhode Island Optometric Journal. 19.3.3. 1948.

The authors claim that only about five per cent of the eye pathology encountered in routine practice is of ocular origin. The remainder of the pathology affecting eyes is systemic in its origin and for this reason optometrists should refer their cases of ocular pathology to the general practitioner for treatment. The authors point out, however, that the plan should be put in effect only after a mutually satisfactory working arrangement has been agreed to by both the physician and optometrist to assure the patient of proper diagnosis and care.

A. V. H.

## SPECIAL REPORT

# CRITICISM OF CERTAIN DISPENSING PRACTICES AND ITS EFFECT UPON OPTOMETRY*

Joseph G. Majersky† and Carel C. Koch‡
Minneapolis, Minnesota

The civil court action instituted by the Department of Justice recently, indicating that the agency system in the field of eye care is collusive and results in higher costs of ophthalmic materials places the entire field of eye care in an embarrassing position. This action further infers that collections made by the agent for the doctor are in a sense a "rebate" to the doctor.

Most ophthalmologists and many opticians are confronted with the fight to preserve the agency system and optometrists are confronted with the problem of changes which may occur if their fight is unsuccessful. In addition, all suffer because the public suspects alleged improprieties in and around the personal procedure of getting glasses.

At this time estimates indicate that about 70 per cent of all glasses are prescribed by optometrists. As a rule these men do their own dispensing and the patient is presented with a bill for a total fee, which includes a refracting fee, a dispensing and servicing fee, and the price-to-patient of the materials used.

Physicians who practice ophthalmology are reluctant to forego the advantages of the agency system because (1) it permits their refraction fee to be lower, thus keeping them in a better competitive position with optometrists, and (2) because it gives them complete control of the quality of glasses which will be used by their patients. This latter point is important because in the hands of an unscrupulous optician these may vary widely when of inferior quality or dispensed in a careless manner. The ophthalmologist has no control over the actions of an independent optician.

Furthermore, the ophthalmologist under the agency system is free to examine eyes and treat ocular pathology without the inconvenience

*Submitted on February 15, 1948, for publication in the April, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Editorial Assistant, American Journal of Optometry and Archives of American Academy of Optometry.
‡Optometrist. Fellow, American Academy of Optometry. Editor, American Journal of Optometry and Archives of American Academy of Optometry.

of dispensing glasses in his own office. As every optometrist knows, dispensing when done properly is a time consuming job, which many eye surgeons would find impossible because of inadequate knowledge of ophthalmic materials and lack of time.

To the public the ophthalmic professions are irremediably interwoven. The optician, the ophthalmologist and the optometrist are all part of that family of health workers who supply the nation with glasses. That they do more than this is secondary. In large part their work is that of correcting visual disorders and it is at this point that their great contacts with the public occur.

Of this group the optician has the greatest heritage. Since the 14th century his has been a noble calling of great benefit to mankind, and the ranks of his profession are studded with the names of scientists who will live through the ages.

The ophthalmologist,* as we now know him, came next. Early in the 19th century physicians first became interested in eye examinations. Brought into this field through their interest in pathology, they took up the correction of myopia, hyperopia and astigmatism using the anatomical and physiological knowledge of their day and through this work have made notable advances in refractive techniques. Being physicians their interest in the physiology of vision came first, while the optician of that day contributed to the science by his additions from the field of physics and physiological optics.

The optometrist came last. He was a direct offshoot of the optician. Taking something from the researches of the ophthalmologists and much from the field of physiological optics, he developed a specialty of eye-examining techniques to bring to the entire practice many refinements in the correction of visual disorders. In the latter part of the 19th century the work of the optometrist was first recognized as a separate entity from that of the optician. The optometrists were refractionists. They examined eyes and prescribed glasses. Opticians filled the prescriptions for both optometrists and ophthalmologists. During this transitionary period some opticians still examined eyes and some optometrists ground lenses and filled prescriptions and it was not until around 1920 that the lines of their respective spheres of activity became quite clear.

During all this time, however, ophthalmologists had been writing ocular prescriptions and opticians had been filling them. In addition most opticians also examined eyes and filled their own prescriptions.

*Also known as oculists and eye, ear, nose and throat specialists.

As the transition from optician to optometrist became more evident, two things happened. First, the optometrist did more and more eye examining, and second, ophthalmologists became reluctant to send their patients with prescriptions to the optician-optometrist of that day. The reason for this reluctance was two-fold—first the danger of losing the patient, and second, that some of the ophthalmic work done at the start of the 20th century was of poor quality. Much of the material used in making glasses was then poor and the glasses were not too effective in many instances.

Shortly after 1900 a new method of dispensing developed. Certain opticians who had given up eye examining to specialize in the making of glasses became agents for ophthalmologists. In other words, they filled all of the prescriptions written by the ophthalmologist.

This ophthalmologist-optician relationship with the optician as agent for the ophthalmologist had certain advantages for both. The ophthalmologist could insist on quality materials and accuracy in lens design and curves, and he also could supervise in a general way the costs of these materials to the patient. The optician was assured a steady flow of work from the ophthalmologist. The public benefited by the general excellence of the work of these dispensing opticians. Prices were also kept in line by outside competition as patients frequently "shopped around" from one dispenser to another before having their prescriptions filled.

Most of these agent-dispensing opticians started as small one-man shops. Many remained small. Others grew because of the quality of their work and became wholesalers of ophthalmic lenses and frames as well as agents. Some agents affiliated with manufacturers. Many of these businesses are now nearing their 50th birthdays. These laboratories can be found today in nearly every part of our country.

During this 50-year-period the optometrist was also active. At first he did much of his own laboratory work. He did lens grinding as well as eye examining and refracting. Gradually he devoted more and more time to visual care and less time to the fabrication of glasses, which he purchased at "wholesale" prices from the dispensing opticians who had entered the wholesale field. His work differed in one major respect from that of the ophthalmologist. The optometrist delivered the glasses to the patient himself, while the ophthalmologist left that work to the agent-dispenser or to some dispensing optician of the patient's choice.

As the optometrist generally did his own dispensing he was only

brought into direct contact with the agent-dispensing system occasionally. This occurred when one of his patients happened to go to the dispenser for eyeglass repairs or for a duplicate pair of glasses. The agency system then worked for him as it did for the ophthalmologist.

The contentions raised by the Department of Justice present a question which will have to be decided by the court.

If the present agency system is abolished and ophthalmologists divorce themselves from agency dispensing, two things are apt to happen. First, the ophthalmologist's refraction fee will be increased, and second, the agent-optician will reduce his charges on materials to the patient to a dispensing fee and the wholesale or laboratory cost of the materials. The net result of these changes will probably not be a marked reduction in the total cost of visual care to the patient, but will necessitate optometrists meeting this move by a like readjustment of their present fee schedules.

For years the American Optometric Association has been studying this problem. Members of this group have proposed steps which may be taken by optometrists to readjust their practices in the event this becomes necessary. It now looks as though a decision will be reached and those optometrists who have not already done so should now conform to professional standards or they may find themselves unable to successfully meet the conditions which would be present if all ophthalmic materials were materially reduced in cost to the patient but remain at the present price level to the optometrist.

This Journal has stressed the need for professional practice among optometrists for years with considerable success. Optometrists whose practices are professional will meet these readjustments, if they come, with no particular difficulty.

To those optometrists in essentially commercial surroundings we again suggest the complete revamping of their practices and their mental attitude toward their work. Unless this is done, the future holds little in store for them.

1502 FOSHAY TOWER
MINNEAPOLIS 2, MINN.

---

## TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

**A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.**

### NEW MEMBERS OF THE ACADEMY

The following optometrists, educators and scientists were elected to Fellowship in the American Academy of Optometry during the quarter ending March 31, 1948. The Executive Council welcomes these new members.

Dr. Otto J. Bebber, 509 Mack Bldg., Denver, Colorado.
Mr. Norman Bier, 37 Manchester St., London W. 1, England.
Dr. Willis Brown, 602 Elgin Tower, Elgin, Illinois.
Dr. Horace Carpenter, Harris Bldg., Rutherfordtown, North Carolina.
Dr. Henry B. Day, 603 Security Bank Bldg., Raleigh, North Carolina.
Dr. Jule S. Deans, 904½ B St., North Wilkesboro, North Carolina.
Dr. Preston W. Green, Mount Airy, North Carolina.
Dr. James H. Grout, Northern Illinois College of Optometry, 4170 Drexel Blvd., Chicago, Illinois.
Dr. John A. Hattstrom, 1724 Sherman Ave., Evanston, Illinois.
Dr. George J. Haus, Southern College of Optometry, 865 Washington St., Memphis, Tennessee.
Dr. Arthur Jampolsky, Stanford Hospital, San Francisco, California.
Dr. James B. Kirk, 106 E. Maumee St., Adrian, Michigan.
Dr. Herman Klein, 210 Dauphin Bldg., Harrisburg, Pennsylvania.
Dr. G. L. Lang, 7½ So. Union St., Concord, North Carolina.
Dr. Deo M. Lowden, 5305 Hohman Ave., Hammond, Indiana.
Dr. Harley G. McCormack, 2629 Sheridan Road, Zion, Illinois.
Dr. John Mahn, 58 East Washington St., Chicago, Illinois.
Dr. Bernard Mazow, 1013 Shell Bldg., Houston, Texas.
Dr. Richard A. Needles, Northern Illinois College of Optometry, 4170 Drexel Blvd., Chicago, Illinois.
Dr. J. Smith Nifong, 304 O'Hanlon Bldg., Winston-Salem, North Carolina.
Dr. W. W. Parker, McIntyre Bldg., Lumberton, North Carolina.
Dr. Robert J. Pearce, 504 Banner Bldg., Greensboro, North Carolina.

Dr. Onofrey G. Rybachok, Pennsylvania State College of Optometry, 12th and Spencer, Philadelphia, Pennsylvania.

Dr. John R. Schafer, First National Bank Bldg., Statesville, North Carolina.

Dr. Reginald L. Secord, 947 West Eighth St., Los Angeles, California.

Dr. Seymour L. Shaw, 35 Twelfth St., Wheeling, West Virginia.

Dr. Donald D. Slater, Evans Hotel Bldg., Hot Springs, South Dakota.

Dr. Nat Walker, 147½ So. Main St., High Point, North Carolina.

Dr. Lee M. Wheless, 403 Security Bank Bldg., High Point, North Carolina.

Dr. John Zettel, Jr., 612 Enquirer Bldg., Cincinnati, Ohio.

## CHAPTER ACTIVITIES

### SOUTHERN CALIFORNIA CHAPTER

The topic of discussion at the February meeting of the Southern California chapter was a slight departure from the field of optometry. The speaker of the evening was Mr. Clark Sellers, world authority on detection of spurious documents. Mr. Sellers described to Academy members his work with the F.B.I., Scotland Yard and the United States Secret Service.

### NEW JERSEY CHAPTER HONORS NEUMUELLER

Dr. Julius F. Neumueller, retiring president of the New Jersey chapter, was guest of honor at a testimonial dinner April 14 at Trenton. Members of the chapter gave the dinner for Dr. Neumueller not only in recognition of his chapter work, but also for his contributions to optometry and the public as a teacher, lecturer, author, scientist and practitioner.

Dr. Harold Simmerman, Woodbury, New Jersey, was elected chairman of the New Jersey chapter of the Academy at its March meeting.

Also elected at the meeting were the following: Dr. John R. Wittekind, Morrisville (Pennsylvania), vice-chairman; Dr. Philip Jackman, Hackensack, secretary, and Dr. Herbert Ratliff, New Brunswick, treasurer.

MINNESOTA CHAPTER

Two important subjects in the field of optometry will come up for discussion at the May meeting of the Minnesota chapter. The first half of the seminar will be devoted to a study of the visual problems of industrial workers, the second, to visual skill tests currently being used by educators and practitioners. The meeting is scheduled for May 9 in Minneapolis.

EASTERN PENNSYLVANIA CHAPTER

Guest speaker at the March meeting of the Eastern Pennsylvania chapter of the Academy was Dr. Jacob Nevyas, professor of chemistry, Pennsylvania State College of Optometry. Dr. Nevyas discussed "Viruses and Heredity."

INDIANA CHAPTER

Dr. W. L. Van Osdol, Indianapolis, was elected secretary-treasurer of the Indiana chapter at a special election held at the winter meeting. The election was held following the resignation of Dr. J. R. Shreve from the secretary-treasurer office.

Indiana members also decided at the meeting to again invite the Indiana Optometric Association to their spring seminar—a plan previously followed with success. The date for the seminar has not, as yet, been set.

---

## CURRENT COMMENTS

Virginia Huck
**Editorial Assistant**

**Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.**

DARTMOUTH BIBLIOGRAPHICAL INDEX TO COLUMBIA UNIVERSITY

Two important gifts in the field of vision and optical science have been made to the Columbia University Library, it was announced recently by Dr. Carl M. White, director of libraries and dean of the school of library service.

One gift is the bibliography section of the library of the former Dartmouth Eye Institute. It was made possible through the efforts of Clifford L. Treleaven, associate professor of optometry at Columbia, and Robert E. Bannon, formerly of the Dartmouth Eye Institute staff. Dr. Bannon is now a member of the faculty of optometry at Columbia. The Dartmouth Eye Institute, formerly affiliated with the Dartmouth Medical School, closed in June, 1947.

The other gift is from the private collection of Dr. Herman Gould, 45 Plaza Street, Brooklyn. It includes a large number of books on vision and related subjects.

The Dartmouth material, which has been placed in the general science section at Low Memorial Library, will provide valuable reference sources for physicists, psychologists, artists, optometrists and scholars in the various fields of vision. The bibliography includes a 50,000 card index file of important papers in the field published during the last two decades, and a file of several hundred reprints of articles related to investigations in the field of binocular vision. There are also 300 translations of important German publications relating to binocular vision, space perception, refraction, visual acuity and allied subjects.

The collection of Dr. Gould, who has retired and is now living in Florida, will be placed in the Optometry Library of Pupin Hall.

HOW GOOD ARE CONTACT LENSES?

Just how good are contact lenses? This is the question now being asked by the visually-deficient public which only a short time ago was wondering, "What are contact lenses?"

Typical of investigations now being conducted is the one recently completed by *Today's Woman*, a magazine for young wives. The results of the survey appeared in the March, 1948, issue.

The verdict is one which, we believe, is rapidly becoming the consensus everywhere.

"In summary," says the reporter for *Today's Woman*, "my investigative excursion into this newest and most exciting battleground of science's battle against defective sight convinces me that contact lenses are, generally speaking, 'good.' Many people are wearing them happily and comfortably. Much progress has been made toward ultimate perfection; more progress is undoubtedly in the offing. Meanwhile, for many people who must keep the 'windows of their soul' brighter by some artificial means, they have proved themselves a blessing in disguise."

To reach this conclusion, writer Nanette Kutner interviewed both doctors and patients, and watched the contact lens fitting process.

The article is of vital interest to optometrists interested in contact lenses as it reflects the opinion of a substantial segment of the feminine public. And though the results of the investigation were favorable, reactions of many patients were not good. Many said they had never worn their contact lenses after being fitted. One reason, the reporter

said she felt after extensive interviewing, was that the lenses were prescribed by "unscrupulous quacks attracted to the contact lens business by the promise of easy money." It isn't news to Journal readers that racketeers are in the field, but the report does point up the necessity for an even more concentrated battle against unethical practices.

However, the author blamed the dissatisfied patients themselves as well as racketeers and unprofessional practitioners for discouragement among contact lens wearers. "These dissatisfied customers have themselves to blame for not going to the legitimate contact lens people," she says, pointing out that the truly professional eye specialist does not advertise or guarantee lens wearing periods that are unattainable, and does not prescribe contact for patients who will not benefit by them.

ONE MAN'S VISION

"One Man's Vision," a tribute to the late Charles O. Cozzens of the American Optical Company, is now available in book form. The article, written by Drs. E. LeRoy Ryer and Elmer Hotaling of New York, originally appeared in the OPTICAL JOURNAL AND REVIEW OF OPTOMETRY. In the book, the authors review Mr. Cozzens' untiring efforts to professionalize eye care. Inquiries about the book should be directed to the American Optical Company.

SECURITY ADMINISTRATION STUDIES HEALTH

Nearly 1,000 professional and lay people will gather in Washington, D. C., May 1-4, to discuss ways to improve the health of the nation. The assembly was scheduled by the Federal Security Administration in response to a request from President Truman early this year. At the meeting, authorities from the fields of medicine, rehabilitation, social work and welfare will map out a 10-year health program for the nation. According to Federal Security Administration officials, the main discussion will center around rehabilitation needs of disabled Americans, and the extent to which the needs are not being met.

LEADERSHIP AWARD PRESENTED MINNESOTA OPTOMETRIST

An award for outstanding leadership in Minnesota was presented to Dr. L. L. Stillman, Minneapolis, at the recent Minnesota State Optometric Association's annual convention. Dr. Stillman was president of the group. The award, a watch pendant inscribed "For Leadership in Minnesota," was made by the MINNEAPOLIS STAR-TRIBUNE. In addition to the pendant, Dr. Stillman received a framed certificate which commended him for "service to Minnesota that has added to the state's supremacy as a place in which to live and work, has brought additional

respect to his organization, and has enhanced his own prestige as a citizen." Dr. Stillman has been practicing optometry in Minneapolis since 1926.

NAVAL NEEDS REVIEWED BY SULLIVAN

Optometry has proved its value to the armed forces and is a growing unit of the medical corps, a Navy commander told the March graduating class of Pennsylvania State College of Optometry.

"The seed for growth has been planted," Commander R. R. Sullivan, chief of the optometric division, U. S. Navy Medical Service Corps, said in his commencement night address.

Commander Sullivan reviewed for the 73 graduates the part optometry played in World War II, and future plans for optometry in the armed services. He disclosed that during 1941 approximately 30 optometrists were commissioned in the United States Naval Reserve. These optometrists were on active duty in refracting billets. Under a proposed plan now before Navy officials, there will be 240 Navy medical units with at least one optometrist assigned to each unit, he said.

Dr. Albert Fitch, president and founder of the college, introduced Commander Sullivan.

Of four awards presented at the exercises, three went to one student. Irving Perlmutter, Philadelphia, received the alumni, clinical efficiency and Ben M. Wilson Memorial awards.

The Samuel Levitt Memorial Award, founded in memory of a former PSCO student killed in World War II, was presented to Michael Checchio of Philadelphia, and Rene DeSaulniers of Danielson, Connecticut.

The graduating class included four women and 69 men, 56 of whom were veterans.

---

## ABSTRACT

ENTOPTIC PHENOMENA AND THEIR RELATIONSHIP TO OCULAR SYMPTOMS. M. Cuthbert. Indiana Optometrist. 20.2.7-10.1948.

The author reviews several types of entoptic phenomena, (1) the shadows due to a difference in optical density called muscae volitantes, (2) halos both physiological and pathological, (3) after images, and (4) prolonged stimuli. He points out in his discussion of pathological halos that the glaucomatous halo, depending upon the diameter of the droplets of corneal edema, will measure from 7 to 12 degrees. Halos due to lenticular fibers will seldom reach 7 degrees. Halos due to abnormalities of secretions on the corneal surface are usually 12 degrees or more.

Cuthbert measures the size of the halos as follows: the test is conducted in a dark room with a small bright light as the fixation object on a tangent screen as a background. The distance from patient to screen should be ten feet and the diameter of the outer ring is measured. Under these conditions, claims Cuthbert, a diameter of 17 inches represents 8 degrees and anything greater than that should be regarded suspiciously as glaucomatous in nature or at least of corneal origin.

C. C. K.

---

# CORRESPONDENCE

## CONTACT LENS EXPERIMENTS OF THOMAS YOUNG

To the Editor:

In the course of a staff seminar of the Cleveland Contact Lens and Visual Center the writer[1] pointed out that the British Astronomer Sir John F. Herschell is generally credited with being the first to suggest the idea of a contact lens. It was stated that Herschell's suggestion was made in 1827 and that sixty years later, F. E. Muller fit a blown cover glass to an eye, while in 1888, A. Fick prescribed what may be considered the first pair of contact lenses.

These facts are in agreement with the description given by most contact lens historians.[2]

Therefore, I was somewhat surprised to discover that in 1801, Thomas Young made and wore a contact lens.[3] Young's contact lens was made in conjunction with his experiments designed to demonstrate that the cornea was not the agent whereby the eye accommodated for near objects. He stated: "From a small botanical microscope I take a double convex lens having a radius and focal length of 0.8 inch, which is fastened in a socket one-fifth of an inch deep; securing its edges with wax, I drop into it a little moderately cold water till it is three-fourths full, and then apply it to my eye, so that the cornea projects into the socket and is everywhere in contact with the water."[4]

I appreciate this opportunity of making this correction.

MATHEW B. ALPERN

SCHOOL OF OPTOMETRY
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO

1. Alpern, M.B., Introduction to the Study of Contact Lenses. Proceedings of The Staff of The Cleveland Contact Lens and Visual Center. Cleveland, 1947. Unpublished.
2. (a.) Obrig, T.E., Contact Lenses for Ametropia, Arch. of Ophth., 1937, pp. 1091-1092. (b.) Obrig, T.E., Evolution of the Plastic Contact Lens, Optical World. October, 1946. (c.) Feinbloom, W., Contact Lenses, Trans. Amer. Acad. of Optometry, V, 1930, p-156. (d.) Dickinson, F., Hammond, Hammond & Company, Ltd., and Hall, K. C., Introduction to the Prescribing and Fitting of Contact Lenses, London, 1947.
3. Young, T., On the Mechanism of the Eye. Phil. Trans. 1801, p-23.
4. Helmholtz, H. V., Handbuch der Physiologischen Optik. Hamburg und Leipzig. 3rd. Ed., (Translated by Southall, J. P. C., published by the Optical Society of America, 1924) p-153.

# Have you thought of your patient's double life?

**Do the case histories** of your patients reveal daily exposure to excess light? If so, mere spherical, cylindrical or prismatic correction may not be sufficient for day long comfort, unless the ophthalmic prescription specifies — "Soft-Lite Lenses." Soft-Lite Lenses, providing light absorption in whatever degree is required, give the final refinement that results in *comfort* during *all* of your patients' waking hours.

*The Soft-Lite National Educational Program promotes better eyesight by encouraging periodic, professional eyesight examination.*

## Soft-Lite Lenses

**Internationally prescribed for light sensitive eyes**

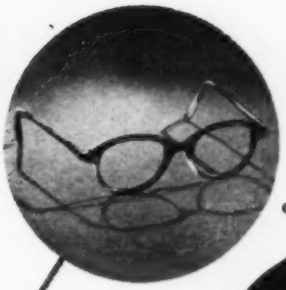
variety

*top:* CALICO HUSSY — *check*

*centre:* MIDWAY — *mottle*

*bottom:* "17" — *polka dot*

b



c

d

# ys the spice of life

e

f

Whether it's men or women, teen-agers, or young children, Kono provides the very widest variety of precision-built frames for every personality, mood, facial contour, and professional ophthalmic prescription. Whether it is gleaming plastic, sparkling pearl imprisoned fabric, or a gold-trimmed creation, Kono supplies the finest in fashioned frames for the fastidious. For every variety in every frame form, specify Kono when you order from your local supply house.

*a HUSSY*
*b "17"A*
*c CLIPPER (8 diff.)*
*d CLIPPER E (5 diff.)*
*e "400"*
*f WINGER — seashell*

"INSURANCE FOR MODERN STYLE"

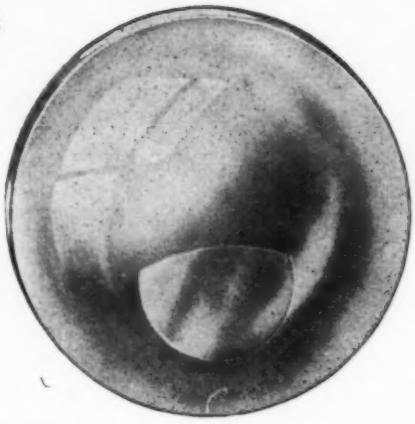
**THE KONO MANUFACTURING COMPANY**

69-24 FORTY-NINTH AVE., WOODSIDE, N. Y.

55 E. WASHINGTON ST., CHICAGO, ILL. • CHARLESTON, S. C.

*Precision made, infra-red absorptive Therminon now available in oval-top bifocals.*

Therminon "A" Bifocals are of the same high quality that has made Therminon lenses so well known for providing eye comfort and protection.



WRITE FOR COMPLETE INFORMATION
"COOL FILTERED LIGHT IS BEST FOR SIGHT"

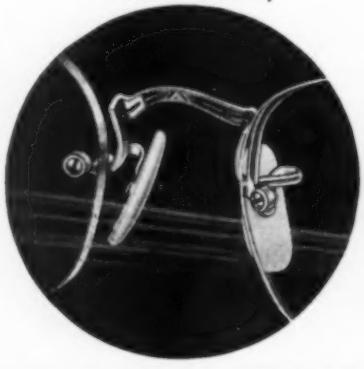
**THERMINON LENS**
**CORPORATION**
*MANUFACTURERS OF THERMINON . . . AND OTHER FINE OPHTHALMIC LENSES*
**63rd & UNIVERSITY AVE. DES MOINES 11, IOWA**

RIMWAY FUL-VUES

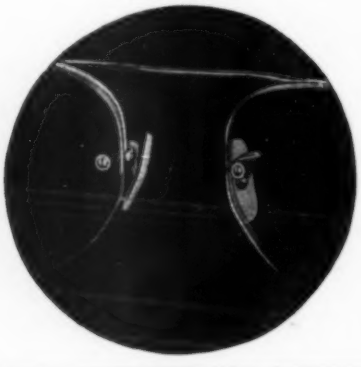
**Cushioned Against Breakage** Cushion-Mount Rimways differ from ordinary Rimways. They have the famous Duratex cushioning that has proven a boon against lens breakage. A Duratex filled strap seat protects on one side, a Duratex lined washer on the other and the Duratex is carried down into the screw hole. No metal touches glass. Shock and strain are absorbed. Breakage is minimized.

In stock at Johnson's and ready for delivery are the 2 Cushion-mount Rimway styles below.

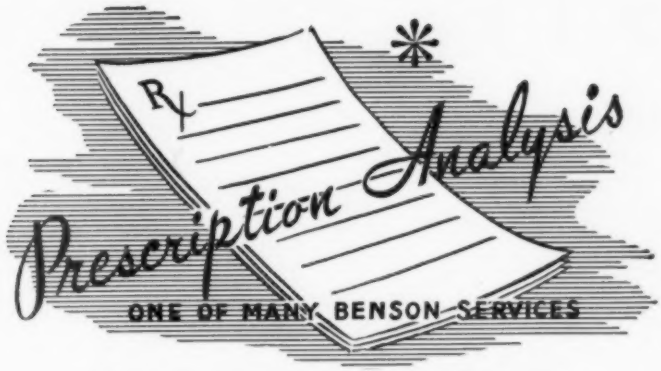
**The Canterbury**



**The Hibrow**



*Johnson Optical Co.*
**Successor to JEFFERY OPTICAL CO.**
**301 Phy. and Surg. Bldg.**
**Atlantic 2469 Minneapolis**




LENS GRINDING • LENS TEMPERING
CONTACT LENSES • NATURFORM All-Plastic EYES
ORKON LENSES (Corrected Curve) • JULETTE (Jeweled Lenses)
COSMET EDGES (Distinctive Style and Beauty)
HARDx LENSES (Toughened to Resist Breakage)
SOFT-LITE LENSES (Neutral Light Absorption the 4th Prescription Component)

## N. P. BENSON OPTICAL COMPANY

*Established 1913*
MAIN OFFICE AND LABORATORY: MINNEAPOLIS, MINNESOTA
Branch Laboratories:
• Aberdeen • Albert Lea • Beloit • Bismarck • Brainerd • Duluth • Eau Claire • Huron
La Crosse • Miles City • New Ulm • Rapid City • Rochester • Stevens Point • Wausau • Winona

To Greater Bifocal Comfort—Clearer Bifocal Vision

## THE ONLY FLAT TOP ONE-PIECE BIFOCAL

## ULTEX K

K Ultex. Complete base stocks are on hand. A reduction
Every ethical optical man will welcome the availability of
in K consumer prices makes it easier for the doctor to
dispense this decidedly superior bifocal.

### BEST BY EVERY OPHTHALMIC TEST

1. Sharp, wide angle vision through **both** reading and distance portion.
2. Optically true surfaces, cold pitch polished like finest instrument lenses.
3. Keen definition, no hazy image from injurious fusing processes.
4. Free of color fringes.
5. Thin segment shoulder; no annoying shoulder reflections.
6. Wider reading field, due to **inside** segment.

MINNESOTA OPTICAL COMPANY

*Minnesota Optical Company*
621 W. Lake St. -:- MINNEAPOLIS, MINN.

# "Optometric Needs"

## DVORINE COLOR PERCEPTION TESTING and TRAINING CHARTS

This is the most complete set of pseudo-isochromatic charts yet devised. In addition to the usual method of screening out the color deficient individuals, the examiner can determine now with these charts the specific deficiency in the subject's color sense; for each chart is limited to two colors only and all of the charts cover the entire range of the major hues of the visible spectrum. These charts also provide adequate material for the teaching of the color ignorant and those with a limited capacity to discriminate between figure and background

**"I regard yours (Dvorine Color Charts) as much better than the Ishihara charts."—J. A. GLAZE, *Professor of Psychology, Kansas State Teachers College***

**2 volumes $25.00**

## ANALYTICAL REFRACTION and ORTHOPTICS

This widely acclaimed book on VISUAL ANALYSIS and VISUAL TRAINING is different from any other book on refraction, for it challenges antiquated theories and offers the reader a new approach to the problem of visual disturbances.

"Since reading the book I have been able to successfully handle the cases that have been giving me untold grief. The immediate prescription and handling of the different type cases which require Orthoptics is covered in a very comprehensible manner."

DR. J. H. DANCY, Los Angeles, Calif.

**Third Edition—Fifth Printing** **Only $4.50**

## DVORINE ANIMATED FUSION TRAINING CHARTS

These Animated Charts were designed to provide for the doctor a quick means of measuring lateral and vertical fusion amplitudes and to provide for the patient a progressively arranged home training method of visual exercises, under the doctor's direction, to correct strabismus, amblyopia, suspenopsia, high and low phorias and other binocular imbalances. In addition to the Animation, produced by a revolving disc, and the profusion of vividly colored designs, the latest edition of this set contains special charts for developing vertical fusion amplitudes and charts for increasing the resolving power of the eye and thus improve distant visual acuity.

**$8.00**

## DVORINE COLOR DISCRIMINATION SCREENING TEST

A new publication consisting of two separately bound groups of pseudo-isochromatic charts known as Group A and Group B. Each group consists of two plates whose hues range from the long to the short waves of the spectrum and the digits are visible only to those who have normal color discrimination ability. The accuracy and the speed of the test make it the ideal screening device, for the response is INSTANTANEOUS.

**Groups A and B, $5.00 Complete**

***Distributed by the author,* ISRAEL DVORINE, O.D.**
**2328 Eutaw Place, Baltimore 17, Md.**
**and Optical Supply Houses**